Leavenworth National Fish Hatchery Tier II Water Quality Analysis

U.S. Fish and Wildlife Service
Leavenworth National Fish Hatchery
12790 Fish Hatchery Road
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Introduction
The Leavenworth National Fish Hatchery (NFH) is required to have a National Pollutant Discharge Elimination System (NPDES) permit issued by the Environmental Protection Agency (EPA) which authorizes its wastewater discharge. In November 2005, Leavenworth NFH submitted an updated permit application to the EPA. As a part of the permit process, Washington Department of Ecology (Ecology) is required to conduct a 401 certification of the permit. To complete the 401 certification, Ecology required that Leavenworth NFH complete a Tier II Antidegradation Analysis.

The Antidegradation Analysis for the Leavenworth NFH includes:

1) Background on the Authorization, Fish Production History, Physical Features, Fish Health Management, Related Activities in Icicle Creek and NPDES Permit History of Leavenworth NFH
2) Current Effects of Leavenworth NFH on Icicle Creek Water Quality
3) An analysis of the known, available, and reasonable methods of prevention, control and treatment to minimize impacts to water quality in Icicle Creek (AKART Analysis)
4) Description of the Necessity for Leavenworth NFH
5) Overriding Public Interest for the operation of Leavenworth NFH

Background
Authorization of Leavenworth National Fish Hatchery
Leavenworth NFH was authorized by the Grand Coulee Fish Maintenance Project, April 3, 1937 and reauthorized by the Mitchell Act (52 Stat. 345), May 11, 1938. The Mitchell Act authorized the Secretary of Commerce "...to establish one or more salmon cultural stations in the Columbia Basin in each of the states of Oregon, Washington, and Idaho." The Leavenworth NFH is one of three mid-Columbia stations constructed by the Bureau of Reclamation (Reclamation) as fish mitigation facilities for the Grand Coulee Dam, Columbia Basin Project. Although reauthorized by the Mitchell Act, funding was provided through a transfer of funds from the Reclamation to the US Fish and Wildlife Service (USFWS) until 1945. From 1945 to 1993, the USFWS had funding, management, and operation responsibilities for the Leavenworth National Fish Hatchery Complex (Complex; made up of Leavenworth, Entiat and Winthrop NFH's). Beginning on October 1, 1993, Reclamation assumed funding responsibility for the Complex while the USFWS continues to manage and operate the three facilities (Leavenworth, Entiat, and Winthrop NFH's).

In addition to the initial authorizations mentioned above, Leavenworth NFH operations are authorized, sanctioned and influenced by the following treaties, judicial decisions and specific legislation:

- Treaty with the Walla Walla, Cayuse, Umatilla Tribes, 06/09/1855
- Treaty with the Yakama, 06/09/1855
- Treaty with the Nez Perce, 06/25/1855
- Treaty with the Tribes of Middle Oregon, 06/25/1855
- Executive Order (Treaty with Bands of Colville), 04/08/1872
- U.S. v. Oregon (Sohappy v. Smith, "Belloni Decision", Case 899), 07/08/1969

- Endangered Species Act of 1973, 87 Stat. 884, 12/28/1973
- Salmon and Steelhead Conservation and Enhancement Act, 94 Stat. 3299, 12/22/1980
- Pacific Salmon Treaty Act of 1985 (U.S./Canada Pacific Salmon Treaty), Public Law 99-5, 16 U.S.C. 3631, 03/15/1985

Fish Production History

When the Complex was first established, spring Chinook salmon and steelhead were identified as the primary mitigation species. The initial operating plan for the Complex called for adult spring Chinook salmon and summer steelhead to be trapped at Rock Island Dam and hauled to Leavenworth NFH for holding and spawning. Salmon and steelhead trapped at the Rock Island Dam represented a mix of fish destined for the upper Columbia River system. Leavenworth NFH was considered to be the primary adult holding and spawning site with eggs being shipped from there to the Entiat and Winthrop NFHs. However, through the years, fertilized eggs were imported from a variety of sources.

Over the years, Leavenworth NFH production program has included a variety of species including spring and summer Chinook salmon, coho salmon, steelhead, kokanee, and various resident salmonids. Since 1974, spring Chinook salmon have been the priority species, and the success of the program provides for sport, tribal and commercial fisheries in the Pacific Ocean, Columbia River and Icicle Creek.

Leavenworth NFH is currently a single species facility rearing only the "Carson lineage" stock of spring Chinook salmon. The Carson lineage stock was derived from fish captured at Bonneville Dam, and these fish represent some unknown admixture of fish from the mid and upper Columbia and Snake River populations. Enough adults return to Leavenworth NFH annually to meet production targets, and Leavenworth NFH has not imported eggs or fry for release into Icicle Creek in more than twenty years.

Currently, Leavenworth NFH targets a release of 1.625 million spring Chinook salmon pre-smolts into Icicle Creek (rm 2.8) during late April. Production goals at this facility were set by the Columbia River Fish Management Plan under U.S. v. Oregon. Initially this plan set a production goal of 2.2 million spring Chinook salmon smolts annually, but this goal was renegotiated in 1991 to 1.625 million for release year 1993 and beyond. The migration corridor for released smolts and returning adult fish includes approximately 489 river miles and the Pacific Ocean. Adult spring Chinook salmon contribute to various sport, tribal and commercial fisheries in the Pacific Ocean, Columbia River and Icicle Creek.

Yakama Nation's Coho Reintroduction Program

Leavenworth NFH provides facilities for rearing and acclimation for up to 750,000 coho salmon pre-smolts. Approximately 150,000 pre-smolt are acclimated from January through release in April in the rehabilitated Foster-Lucas ponds. The remainder of the (approximately 600,000) pre-smolts are transferred to available small and large Foster-Lucas ponds in March and held for approximately six weeks before their release into Icicle Creek in April.

Physical Features

Leavenworth NFH is located three miles south of Leavenworth, Washington, near the mouth of Icicle Creek (Figure 1). Leavenworth NFH shares a point of diversion with Cascade Orchard Irrigation Company (Cascade) in Icicle Creek at rm 4.5. Leavenworth NFH maintains and operates the intake diversion dam and its associated intake structures as part of a 1939 contract between the United States and Cascade. Cascade has a 1905 water right for 12.4 cubic feet per second (cfs) during the irrigation season (May 1st through October 1st) and Leavenworth NFH holds a 1942 water right to divert 42 cfs (18,851 gallons per minute [gpm]) all year long.

The Hatchery's water delivery system consists of four major components and conveyance systems: 1) point of diversion with gravity flow delivery system, 2) Snow/Nada Lakes, 3) the well system on Hatchery property, and 4) water discharge. Leavenworth NFH's water rights are shown in Table 1. Two other physical features in Icicle Creek, Structures 2 and 5, which Leavenworth NFH operates are also discussed below.

Table 1. Leavenworth National Fish Hatchery's Water Rights

CERTIFICATE #	PRIORITY DATE	SOURCE	AMOUNT
1824	03/26/1942	Icicle Creek	42 cfs (18,851 gpm)
1825	03/26/1942	Snow & Nada Lakes	16,000 acre feet
016378	08/01/1939	Groundwater (1 Well)	1.56 cfs (700 gpm)
016379	06/01/1940	Groundwater (1 Well)	2.01 cfs (900 gpm)
3103-A	10/16/1957	Groundwater (1 Well)	2.67 cfs (1,200 gpm)
G4-27115C	10/20/1980	Groundwater (4 Wells)	8.69 cfs (3,900 gpm)

<u>Point of Diversion with Gravity Flow Delivery System</u>

Leavenworth NFH's intake facility contains several components. The intake system relies on gravity flow to convey water from the intake to the Hatchery. A low rubble masonry diversion dam with concrete spillway crest is used to divert water from Icicle Creek into the Hatchery's water delivery system. A pool and weir fish ladder provides fish passage through the diversion dam. Comprised of a concrete base with flash

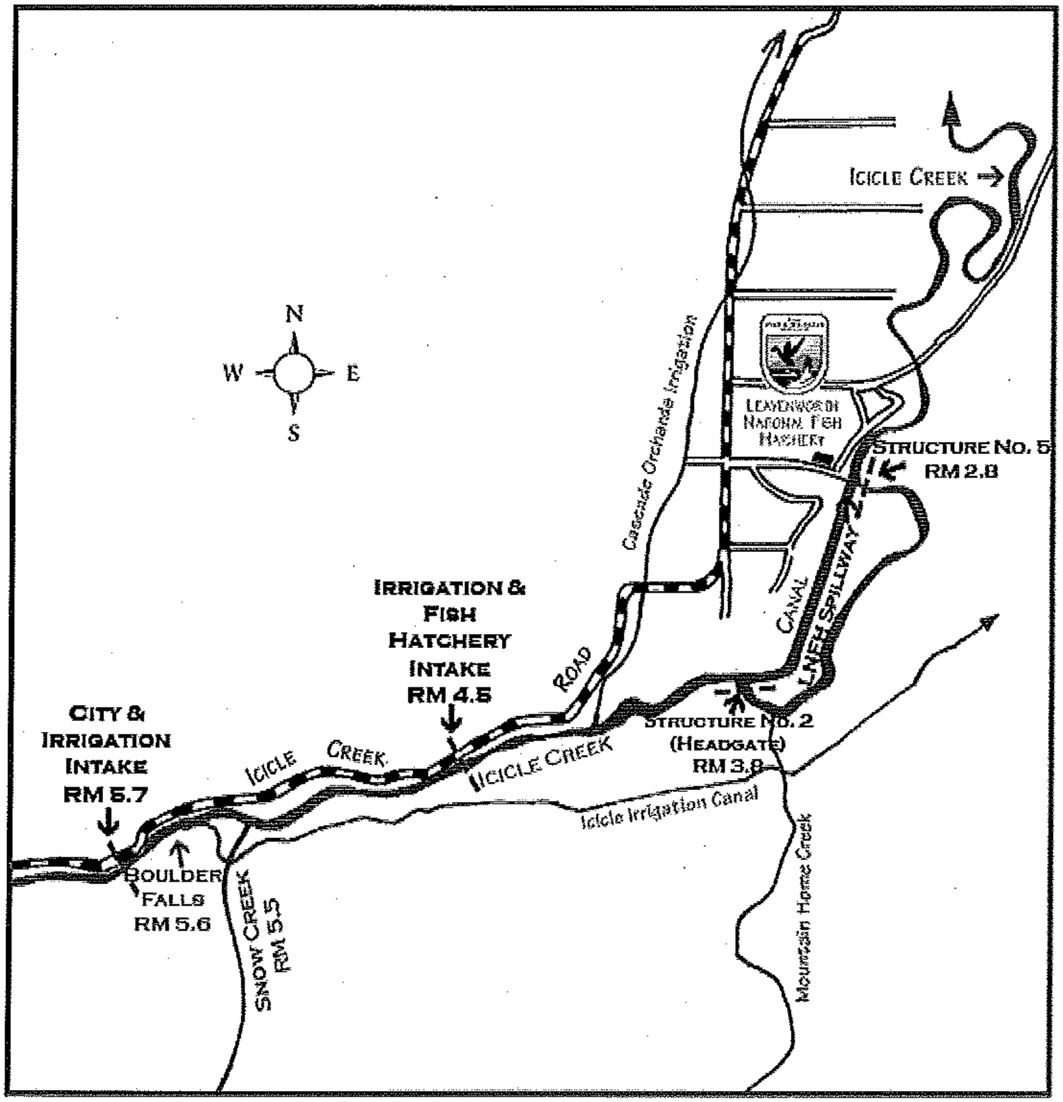


Figure 1. Leavenworth National Fish Hatchery and Vicinity

boards on top, the dam raises water elevations several feet, allowing a portion of the flow to be diverted through the "outside" trash rack (bars spaced at about six inches) and into a concrete water conveyance channel. Regular maintenance associated with the intake includes adding boards to the dam or fish ladder to accommodate fluctuating river flows. Water which enters the conveyance channel is transported a short distance from the "outside" trash rack to a small building which houses the "inside" trash rack (one and one half inch bar spacing), an overflow spill section, and a sediment sluicing section. The outside and inside trash racks serve to limit the size of the debris which enters the pipeline.

Hatchery personnel inspect the intake structure twice daily to remove accumulated debris from trash racks and to ensure adequate flow is entering the conveyance channel. Inspections occur more often during higher flows and accompanying heavier debris loads; and during colder water temperature periods when ice forms on the trash racks. Sediment which settles in the conveyance channel from the diversion dam to the intake pipe needs to be removed occasionally to maintain the depth of the canal. The canal is approximately 100 feet long and 10 feet wide, and the depth of the sediment to be removed varies. Sediment is flushed from the channel by removing dam boards at the lower end of the intake building and fish ladder. Heavy equipment can also be used to remove accumulated sediment.

A discharge channel guides the spilled water and sluiced material back to the creek downstream of the building. Water retained in the system is transported from the inside trash rack into a 33 inch diameter buried pipeline. A slide gate is located at the pipe entrance to regulate flow into the pipe. Approximately 1,260 feet down gradient from the beginning of the pipe system is a gate valve that controls flow into Cascade's delivery system.

A maximum of 42 cfs of surface water is transported through a 31 inch diameter buried pipeline approximately 5,200 feet to the Hatchery. Before water enters the Hatchery, it is either routed into a sand settling basin (normal operation) or directly to the rearing units. The sand settling basin, on occasion, needs to be cleaned of sediment. The sand settling basin is dewatered and the sediment is removed with a front end loader. Any fish entrained are netted and transferred back to Icicle Creek.

From the sand settling basin, water is transported through the main pipeline to one of two separate screen chambers, the "outside" and "inside" screen chambers. These screens, which are composed of vertical static screen panels, are used to filter fish and debris from the Hatchery water supply. There are no fish bypass returns for the screen chambers. The screens are checked twice daily to capture and return fish to Icicle Creek below the spillway dam. Occasionally sediment needs to be removed from the upstream side of the screens.

Snow/Nada Lakes

During construction of the Hatchery, it was recognized that surface flow and temperatures in Icicle Creek might at times be insufficient to meet production demands. A supplementary water supply project in Upper and Lower Snow Lakes, and Nada Lake was therefore developed, and a water right to 16,000 acre feet was obtained (Table 1). These lakes are located approximately seven miles from the Hatchery and about one mile above it in elevation. A half mile tunnel was drilled through granite to the bottom of Upper Snow Lake and a control valve was installed at the outlet end of the tunnel. Water drained from Lower and Upper Snow Lakes enters Nada Lake which drains into Snow Creek, a tributary to Icicle Creek that enters at rm 5.5. Thus, supplemental flows from Snow Creek enter Icicle Creek one mile above Leavenworth NFH's intake system. Icicle Peshastin Irrigation District has rights to 600 acre feet of natural flow from Snow Creek.

The lakes are accessed by helicopter or foot at least twice a year to open and close the control valve. More trips may occur to adjust releases from the lakes and to perform maintenance. Leavenworth NFH operates Snow/Nada Lakes to fully account for its 42 cfs water right from approximately late July to early October (a usual period of operation). This commitment equates to a release of nearly 7,000 acre feet of storage (70 days at 50 cfs), with an estimated 60% probability that inflows to the Snow/Nada Lakes Basin will meet or exceed the released volume (Wurster 2006).

Well System

Groundwater provides the third major component of Leavenworth NFH's water delivery system. Leavenworth NFH operates seven wells, which produce the quality of water needed to sustain the current fish production program. The wells are located on the west bank of the Hatchery Canal. These wells draw water from two aquifers, one deep and one shallow. The deepwater aquifer is not influenced locally by surface water. Well 5 delivers water from this aquifer, while Well 6 has the capacity to draw water from both aquifers. The shallow aquifer is influenced by surface water. Wells 1-4 and 7 draw water from the shallow aquifer. Recharge of the shallow aquifer is affected by how much water is present and thus percolates into groundwater, in the historic channel and the Hatchery Canal. Water pumped from wells 4, 5, and 6 passes through an aeration chamber before entering the Hatchery's pipeline system. Water from wells 1, 2, 3, and 7 enter a series of aeration screens prior to entering the Hatchery's pipeline system at the inside screen chamber. Well water is used to supplement and temper river water to meet production goals. Hatchery production could not be sustained year-around or for long periods of time on either river water or well water alone. When sufficient water is not available for Hatchery operations, available water may be re-used several times and flow rates in the rearing raceways may be reduced for a limited period of time.

Water Discharge

Water diverted into Leavenworth NFH's water delivery system is discharged into Icicle Creek at one of three locations: (1) at the base of the adult pond fish ladder (rm 2.8; Draft NPDES Discharge 001); (2) through the pollution abatement pond (rm 2.7; Draft NPDES Discharge 002); or (3) through a fish release pipe located in the side of the adult pond fish ladder (rm 2.8; This pipe is installed and used for a couple weeks in April when releasing juvenile fish reared in the adult pond; Draft NPDES Discharge 004). The majority of river and well water used for Hatchery operations returns to Icicle Creek at the base of the adult pond fish ladder (Discharge 001) except during pond cleaning and maintenance activities when water is routed through the pollution abatement pond (Discharge 002). All of the river water and groundwater used at the Hatchery is returned to Icicle Creek, minus any leakage and evaporation.

Leavenworth NFH operates and monitors its water discharge in compliance with the original (1974) NPDES permit (NPDES permit No. WA-000190-2). The following parameters are currently monitored at Leavenworth NFH to meet the requirement of the current NPDES permit:

Total Discharge
Flow measured daily in m^3/day (million gallons daily)
Suspended Solids sampled once per month in kg/day and ml/l
Settleable Solids sampled twice per month in ml/l

Cleaning Effluent
Suspended Solids sampled twice per month in mg/l
Settleable Solids sampled once per week in ml/l

Suspended solid samples for total discharge and cleaning effluent are compared to samples collected at the intake during the same time period.

The pollution abatement pond is cleaned approximately every few years. The Chelan-Douglas Health District is consulted to make sure appropriate regulations are followed when the pond is cleaned and the sediment is disposed. The abatement pond was cleaned in April 2007.

Historic Channel (Structures 2 and 5)
Structure 2 is located at the upstream end of the historic channel (rm 3.8, Figure 1) and was designed to control flow in that portion of the creek by raising and lowering the associated gates. Structure 5 (rm 2.8; Figure 1) is a bridge with a foundation to support racks, fish traps and/or dam boards. For most of the year structures 2 and 5 are operated to provide uninhibited water and fish passage through these structures. The only scheduled operational changes to structures 2 and 5 occur during mid-May to early July, the spring Chinook salmon broodstock collection period. At this time, the gates at structure 2 are lowered to reduce flow in the historic channel, and dam boards, racks and fish traps are installed at structure 5 to block and capture fish. Additionally, emergency conditions which require the gates to be closed at structure 2 include:

1.) Protecting downstream structures from flooding
2.) Stimulating emigration of fish released from the Hatchery
3.) Recharging the ground water wells by directing flow down the Hatchery Canal
4.) Maintaining flow characteristics into the spillway pool during the broodstock collection period

Gate closure is necessary under the above conditions and is directly linked to maintaining Hatchery operations. Occasionally, debris has to be removed from the structures to ensure their proper operation and for safety reasons. Material is typically removed by hand, hand tools or with the aid of a backhoe or forklift working from the bridge deck.

Rearing Units
Leavenworth NFH uses 45 – 8 foot by 80 foot raceways, 14 – 10 foot by 100 foot covered raceways, two – 15 foot by 150 foot adult holding ponds, 120 rearing tanks inside the hatchery building, and 540 incubation trays (36 stacks) inside the hatchery building for spring Chinook salmon production. Additionally, coho salmon are typically reared in 20 of the 45 small and three of the 14 large Foster-Lucas ponds in December through April. All rearing units except the large Foster Lucas ponds are connected to the

pollution abatement pond where cleaning effluent is directed. The large Foster Lucas ponds are cleaned with a vacuum, and waste is then directed to the pollution abatement pond.

Fish Health Management

The fish health management objective at Leavenworth NFH is to produce healthy fish that contribute to the program goals. Another equally important objective is to prevent the introduction, amplification or spread of certain fish pathogens which might negatively affect the health of both hatchery and naturally producing stocks.

Administration of therapeutic drugs and chemicals to fish and eggs reared at Leavenworth NFH is performed only when necessary to effectively prevent, control, or treat disease conditions. All treatments are administered according to label directions in compliance with Food and Drug Administration (FDA) and EPA regulations for the use of aquatic animal drugs and chemicals. FDA and EPA consider the environmental effects acceptable when the therapeutant are used according to the label.

Erythromycin injections for spring Chinook salmon female broodstock stock are critical for management of bacterial kidney disease (BKD) and administered each year. Erythromycin treatment helps control horizontal transmission between adults in the holding pond and vertical transmission from the mother to its progeny. All female spring Chinook salmon held at Leavenworth NFH are injected with erythromycin once, in mid-July. An extra-label veterinary prescription allows administration of the drug. Injected carcasses are not used for stream nutritional enhancement or human consumption.

To control external pathogens adult spring Chinook salmon held in the holding ponds are administered a formalin treatment at least three times per week from approximately June through August of each year. Additional treatments may be administered upon recommendation from a Fish Health Specialist.

An iodine compound (approximately 1% iodine) is used to water harden and disinfect eggs after spawning. The eggs are disinfected in 50 ppm iodine in water buffered by sodium bicarbonate (at 0.01%) for 30 minutes during the water-hardening process. Eggs received from other hatcheries are also disinfected in the same manner prior to contact with the station's water, rearing units or equipment.

Occasionally, juvenile fish are treated with formalin to control external parasites. Treating juvenile fish with formalin is not regular or reoccurring, and treatment only occurs when necessary and according to label instruction.

Related Activities

The Icicle Creek watershed has a long history of human impacts beginning with sheep herding and mining in the late 1800's. Recent uses include timber harvest, road building, fire suppression, campground development, private residences, commercial development, and recreation. Five percent of Icicle Creek's watershed, outside of the wilderness boundary, has been directly impacted by logging (USFS 1994). Road building has occurred for development, recreation, and timber harvest. Over 11% of the vegetation along lower Icicle Creek has been removed from private property (WRWSC 1998). The Icicle Creek watershed is a popular recreation area for hikers, rock climbers, fishermen, and many others. Natural disturbances such as fires and landslides are prevalent in the watershed. The 1994 forest fires burned 12% of the watershed (USFS 1994). In 1999, a landslide introduced a large quantity of sediment into the Icicle Creek above Leavenworth NFH.

The flow of Icicle Creek is altered by water diversions which can reduce the flow in the lower reaches to very low levels during the summer and early fall (WRWSC 1998). The City of Leavenworth and the Icicle-Peshastin Irrigation District divert water above the Snow Lakes trailhead (rm 5.7), and Leavenworth NFH and Cascade divert water below the trailhead (rm 4.5). Irrigation diversions can remove 48% and 79% of the mean August and September flows, respectively (Mullan *et al.* 1992).

NPDES Permit History

A NPDES permit was issued by EPA to the USFWS for discharges of wastewater from Leavenworth NFH into Icicle Creek on August 31, 1974. The permit expired on August 31, 1979. USFWS continued to discharge wastewater from Leavenworth NFH subject to the terms and conditions of the expired permit. EPA received an application for reissuance of the permit on November 12, 1980. At that time EPA was unable to process the permit due to budgetary constraints and indefinitely permitted Leavenworth NFH to discharge under the terms and conditions of the permit issued in 1974 (WA-000259-3). In November 2005, Leavenworth NFH submitted an updated NPDES permit application to EPA.

Current Effects of Leavenworth NFH on Icicle Creek Water Quality

Temperature, Dissolved Oxygen, pH, Turbidity and Bacteria Levels

Jim Carroll of Ecology in Olympia, WA conducted modeling analysis on the changes in flow, water temperature, dissolved oxygen (DO), pH, fecal coliform bacteria (FC bacteria), total suspended solids (TSS), and turbidity in Icicle Creek due to the operations of the Leavenworth NFH. A QUAL2K water quality model (Chapra et al, 2003) developed and calibrated for the 2002 Total Maximum Daily Load (TMDL) study in the Wenatchee basin (Carroll et al, 2006) was used to simulate water quality changes to water temperature, DO, and pH.

For the model simulations with and without the Hatchery presence, two flow and meteorological conditions were simulated to give a range of conditions during the critical part of the year for water quality in Icicle Creek. The two flow conditions simulated were:

- August flow condition (used August 2002 conditions which were a little higher than a 7Q2 flow condition with warm mid-summer temperature conditions)
- September flow condition (used late September 2002 which was close to a 7Q10 critical low flow, with cooler fall conditions).

Graphs in Figure 2 shows the August and September flow balances in Icicle Creek without the Hatchery presence. For the simulations without the presence of the Hatchery the following assumptions were used:

- Headwater and groundwater inflow plus tributary flow for headwaters, Jack Creek, and Eightmile Creek were the same as the August 2002 and September 2002 flow balances.
- Using the recessional baseflow record for Snow Creek provided by Fred Wuster, USFWS, Portland OR an 8.4 cfs baseflow for August and 3.8 cfs baseflow for September (respective averages for those months) in Snow Creek without the Hatchery presence was input into the model.
- A water diversion of 7.0 cfs for Cascade was diverted from Icicle Creek at the Leavenworth NFH diversion point.
- All flow in Icicle Creek was routed down the old channel in the simulation without the Hatchery operating.

Graphs in Figure 3 show the August and September flow balances in Icicle Creek with the Hatchery presence. For the simulations with the presence of the Hatchery the following assumptions were used:

- Headwater and groundwater inflow plus tributary flow for headwaters, Jack Creek, and Eightmile Creek were the same as the August 2002 and September 2002 flow balances.
- With the Hatchery presence, a 50 cfs flow was used for Snow Creek in both August and September.
- The same August 2002 flow diversion down the Hatchery Canal was simulated the in August simulation. (Leavenworth NFH now operates structure 2 to send all flow through the historic channel in August. The routing of the flow either through the historic channel or through the Hatchery Canal makes little difference in the modeling results.) All flow in Icicle Creek was routed down the old channel in the September simulation.
- Hatchery diversion and return were the same as in 2002, and includes some supplemental flow return from well pumping.

The addition of 50 cfs from Snow Creek in September distinctly changes the flow balance from that seen in September 2002 (Figure 4). In 2002, there was less than 17 cfs in Snow Creek. Icicle Creek was almost dewatered between the Leavenworth NFH diversion and the Leavenworth NFH return. This meant that almost all of the flow in lower Icicle Creek was from the Hatchery (i.e., the Hatchery had a dilution ratio of nearly one – no mixing zone). The water quality results using a 50 cfs flow in Snow Creek are different from the 2002 TMDL water quality results.

Using the flow balances described above, water temperature, dissolved oxygen, and pH were simulated in Icicle Creek with and without the Hatchery presence. Water temperature was simulated using the 2002 shade measured and calculated for the 2002 temperature TMDL (Cristea and Pelletier, 2005). Meteorology from August and

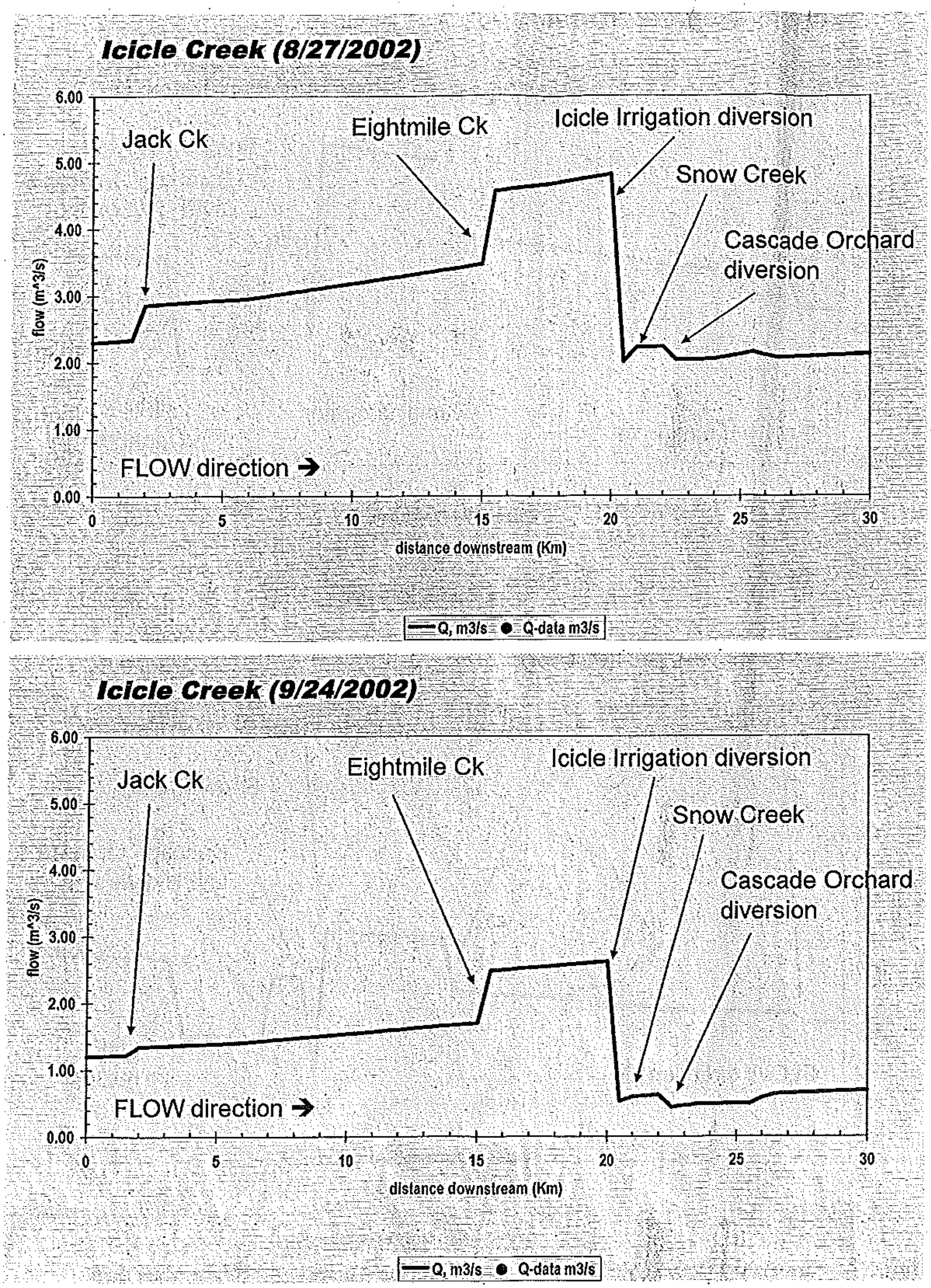
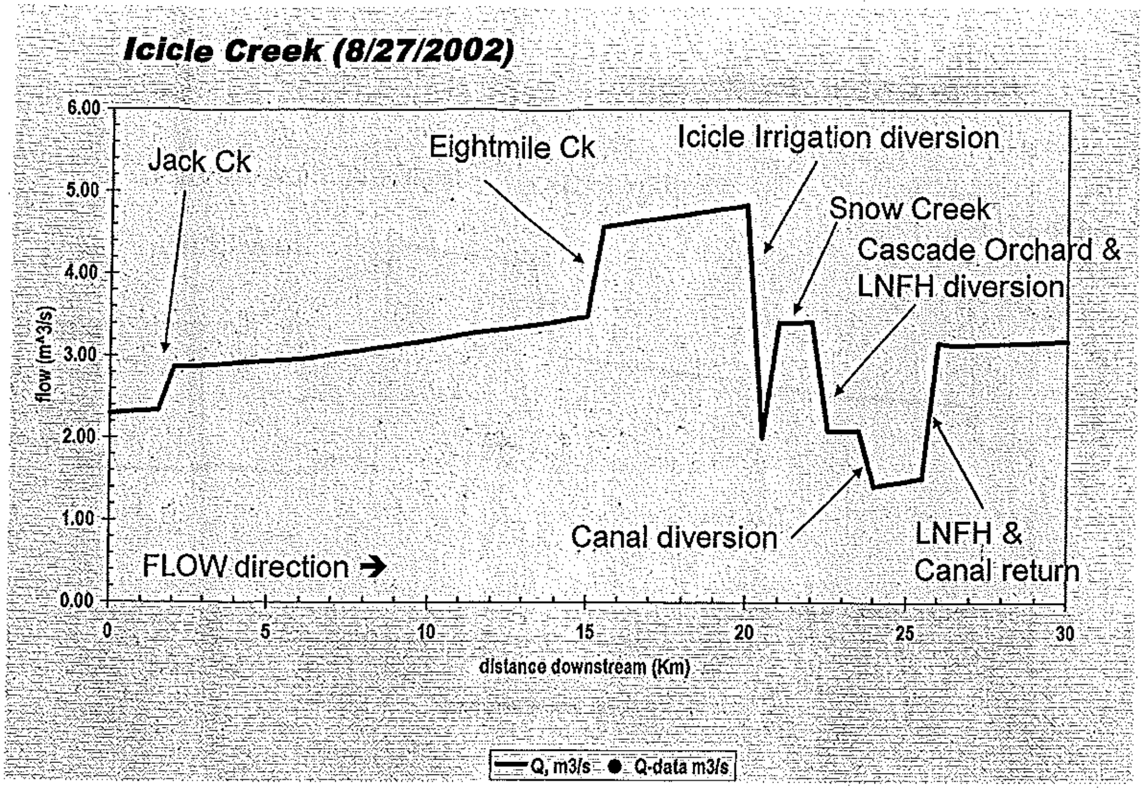


Figure 2. Simulated flow balances without Hatchery presence for August and September flow conditions.



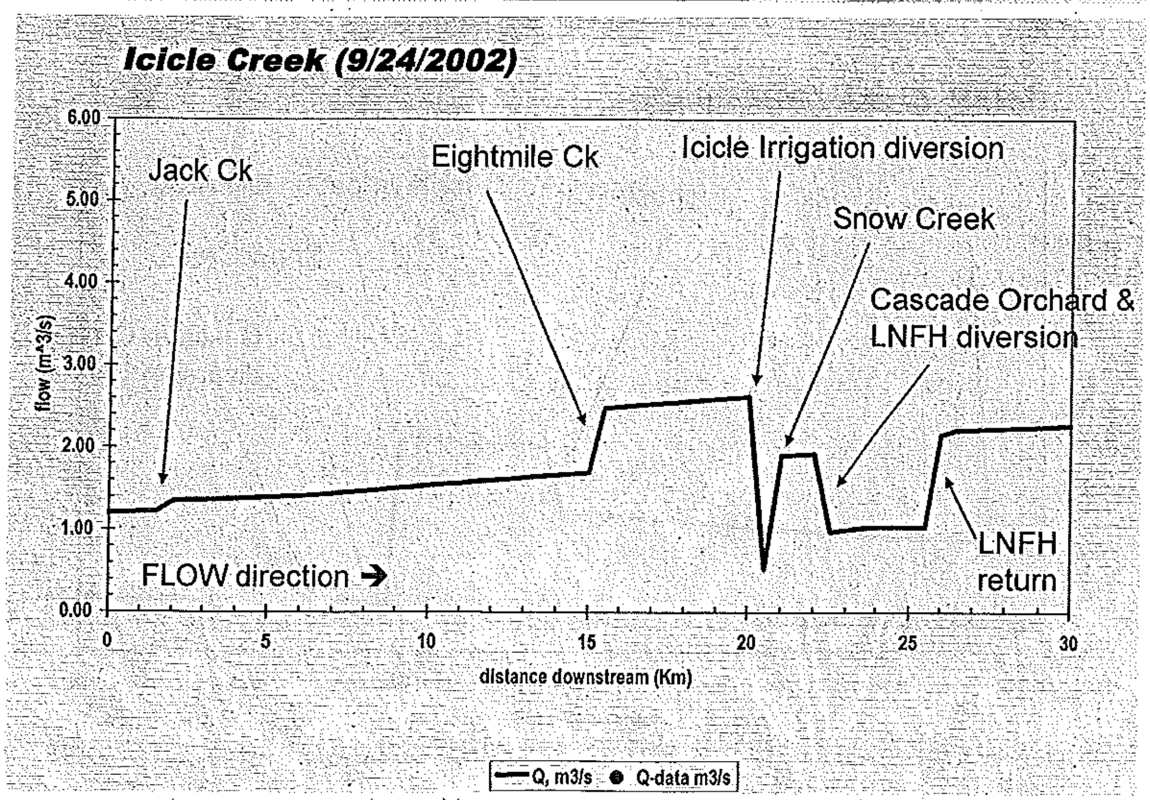


Figure 3. Simulated flow with Hatchery presence for August and September flow conditions. (In August the model shows water is flowing down the Hatchery Canal. This no longer occurs and all water flows down the historic channel in August.)

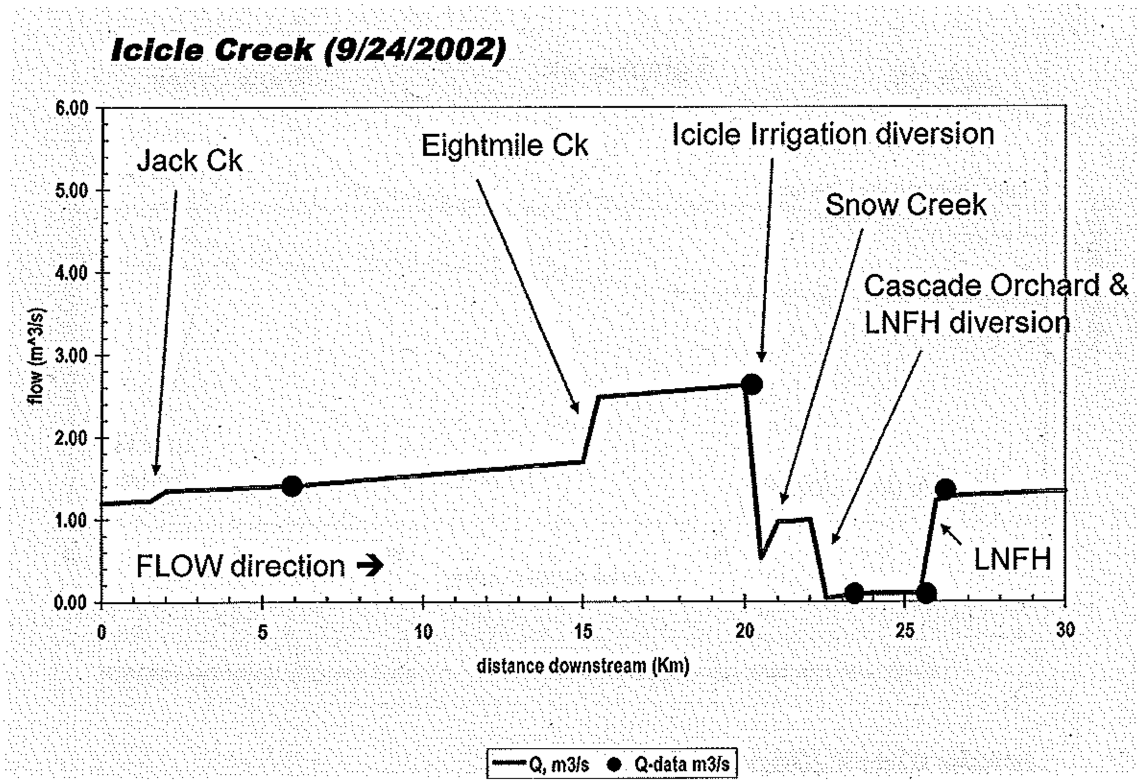


Figure 4. Simulated flow balance in September 2002. Critical conditions for the TMDL in Icicle Creek were based on these flow conditions.

September 2002 was also used in the simulations. Figure 5 shows that the addition of 50 cfs from Snow Creek, which has cooler temperatures, is expected to lower the water temperature of Icicle Creek after mixing. Additionally, the Leavenworth NFH outflow is expected to further cool Icicle Creek, due to the transport and discharge of cooler Snow Creek water through the facility and perhaps also due to the addition of colder groundwater in the Hatchery outflow. The temperature cooling effect of the Leavenworth NFH operations, particularly the addition of colder Snow Creek water, is also expected to increase DO in Icicle Creek (Figure 6). This is mainly due to higher saturation conditions for dissolved oxygen in the cooler water, although there may have been some increase in downstream DO due to increased primary productivity as well.

The increase in productivity in Icicle Creek is related to the concentration of phosphorus in the water because phosphorus is the most limiting nutrient in lower Icicle Creek (Carroll et al, 2006). The Leavenworth NFH operations were the main cause of increased phosphorus loading to Icicle Creek in 2002, although there is some non-point loading in the lower reaches of Icicle Creek. Still, the Hatchery's discharge accounted for approximately 86% of the phosphorus loading to lower Icicle Creek in September 2002 (Carroll et al, 2006).

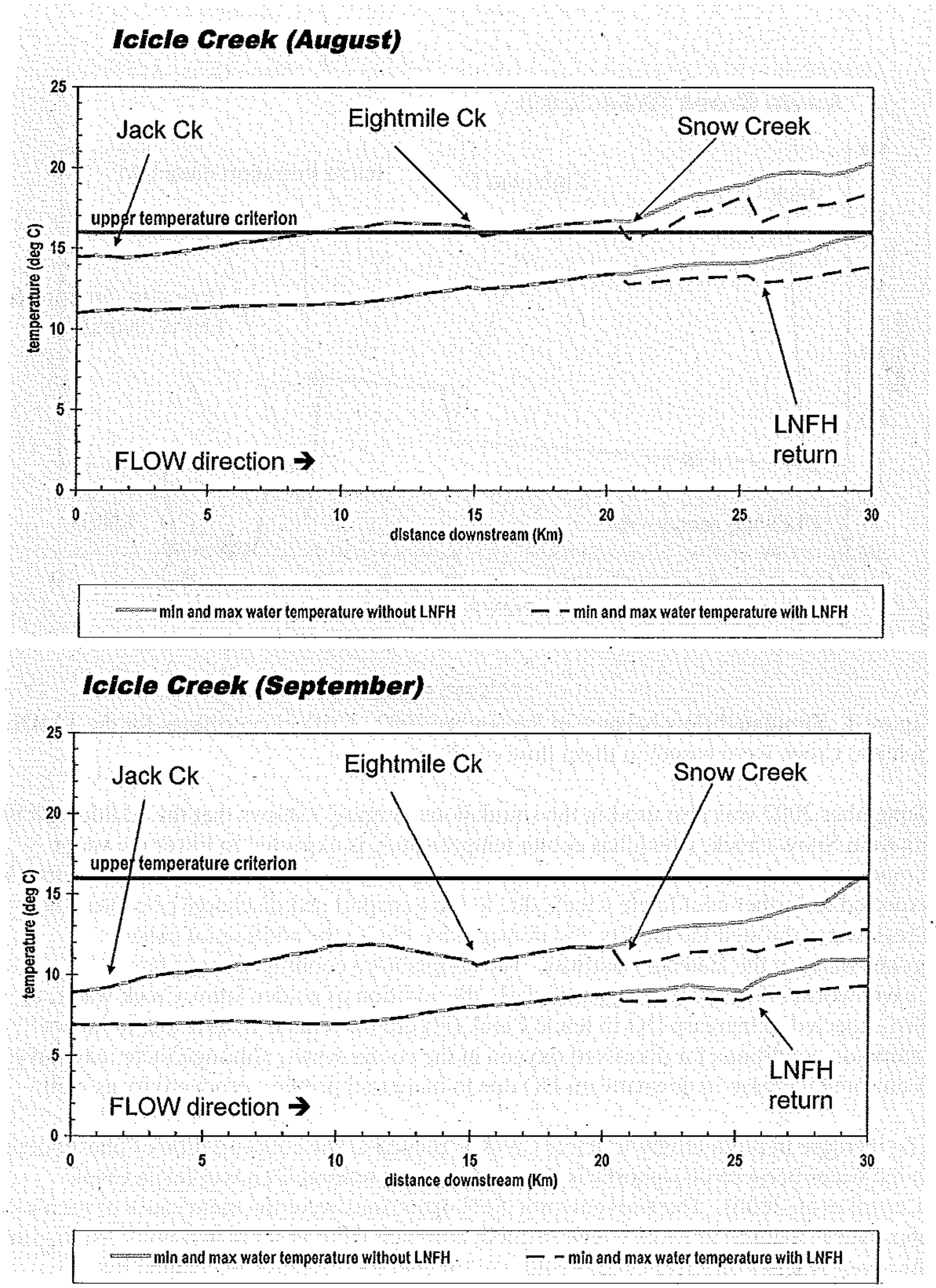
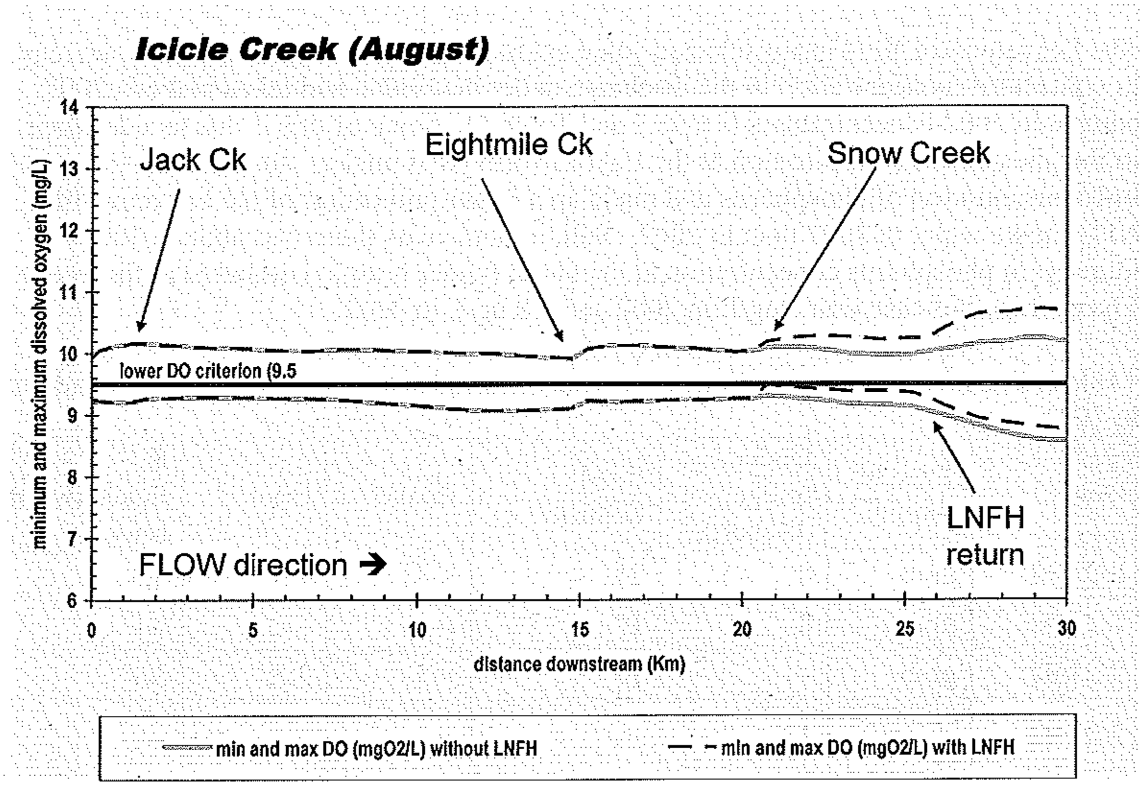


Figure 5. Differences in water temperature with and without the Leavenworth NFH during typical flow conditions found in August and critical low-flow conditions found in September.



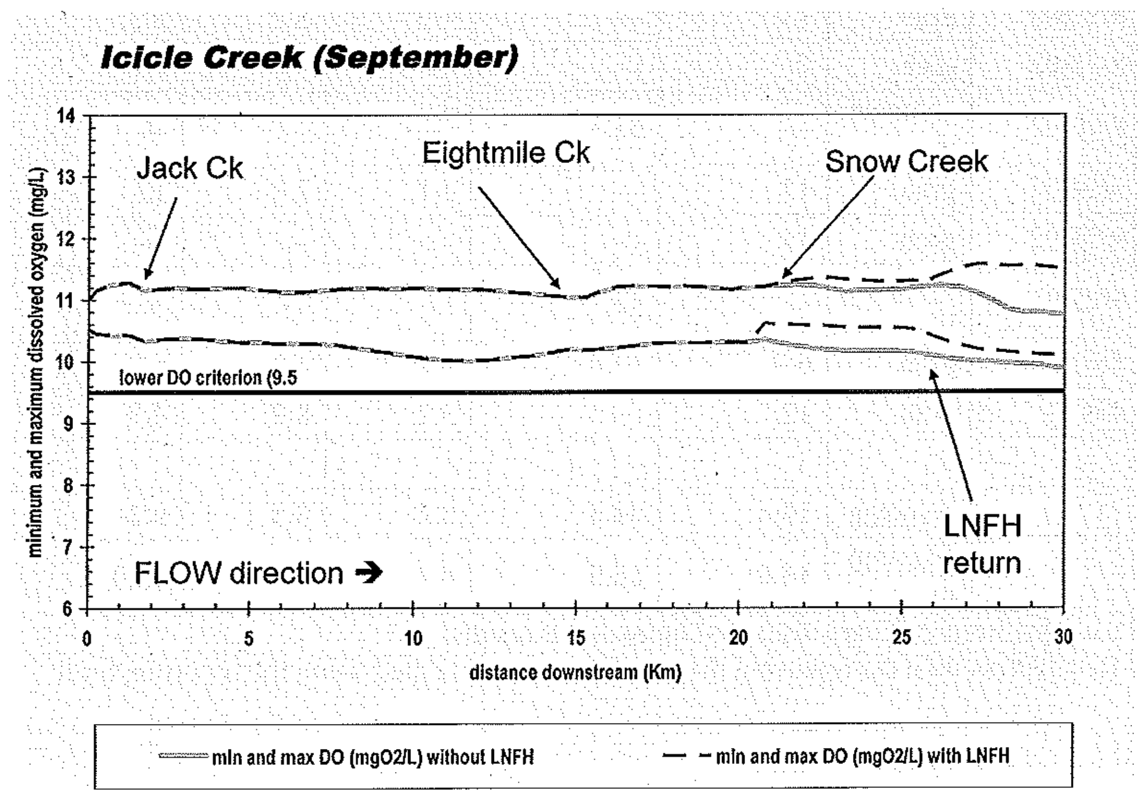


Figure 6. Simulated minimum and maximum dissolved oxygen concentrations in Icicle Creek with and without Leavenworth NFH operations for August and September flow conditions.

The Leavenworth NFH has conducted some operational changes since 2002. A decrease in phosphorus concentration in the discharge under the bridge had taken place in 2007 compared 2002 concentrations (Table 2 and Table 3). Some of this is due to a decrease in the phosphorus concentration at the Leavenworth NFH intake. Snow Creek has a very low concentration of phosphorus and made up a larger proportion of the Leavenworth NFH intake water in 2007 than in 2002. Still, in both years there was about a 300% increase in phosphorus concentration at the outlet (under bridge) compared to the intake. The average increase was 7 ug/L in 2002 and 3.8 ug/L in 2007.

Table 2. Phosphorus concentrations in ug/L from samples at Leavenworth NFH locations in 2002.

Date	Type of sample	Under bridge discharge[a]	Pond Effluent[a]	Intake[a]	Dam 5[a]	E. Leavenworth bridge[a]
6/25/02	grab	8	28	< 3[b]	4.3	3.3
7/22/02	grab	8	17	---	---	---
7/23/02	grab	---	27	< 3	3.5	3.1
7/23/02	composite	12	---	---	---	---
8/27/02	grab	13	---	< 3	5.2	8.5
8/28/02	grab	7	---	---	---	---
8/29/02	composite	---	66.5	---	---	---
9/24/02	grab	13	---	4.1	7.7	12
9/25/02	grab	14	---	---	---	---
9/25/02	composite	---	42	---	---	---
10/22/02	grab	6.9	12.5	4.2	4.3	5.7
4/8/03	grab	12	---	3.2	8.2	4.7
	Average	**10.4**	**32.2**	**3.4**	**5.5**	**6.2**
	Maximum	**14.0**	**66.5**	**4.2**	**8.2**	**12.0**

[a] Samples from 2002 are dissolved inorganic-P results.

[b] Results less than the reporting limit (<3.0) were calculated using the reporting limit.

Table 3. Phosphorus concentrations in ug/L from samples at Leavenworth NFH locations in 2007.

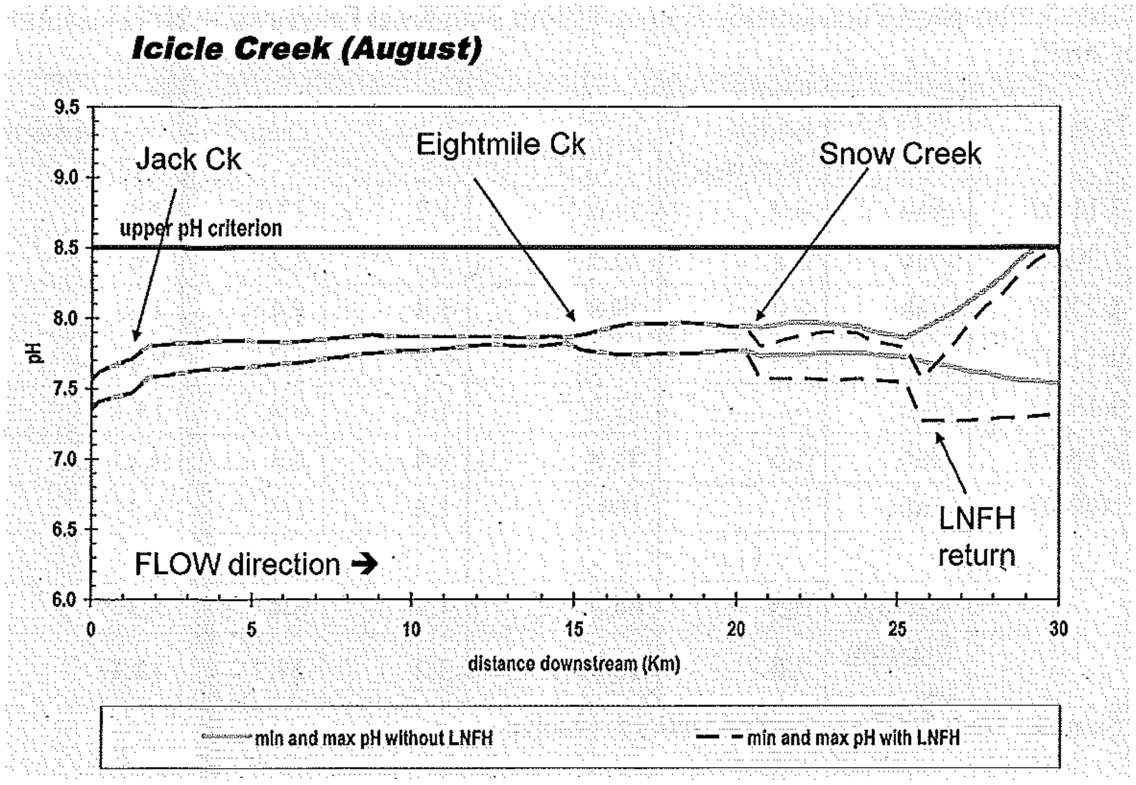
Date	Type of sample	Under bridge discharge[a]	Pond Effluent[a]	Intake[a]	Dam 5[a]	E. Leavenworth bridge[a]
7/11/07	grab	4.9	59.6	1.2	27.7	2.3
7/30/07	grab	6.2	70.3	3.2	4.2	4.6
8/22/07	grab	6.0	58.8	1.4	1.4	4.6
9/11/07	grab	3.5	49.7	1.8	2.0	5.4
9/13/07	grab	---	22.2	1.8	6.0	13.1
9/18/07	grab	5.6	85.8	1.4	2.3	4.1
10/2/07	grab	7	104	1.4	1.4	3.3
	Average	**5.5**	**64.3**	**1.7**	**6.4**	**5.3**
	Maximum	**7.0**	**104**	**3.2**	**27.7**	**13.1**

[a] Samples from 2007 are total phosphorus results.

For the pH simulations, the 2007 average phosphorus concentration of 5.5 ug/L was used for the Leavenworth NFH discharge under the bridge (Discharge 001) and 64.3 ug/L was used for the Leavenworth NFH pollution abatement pond discharge (Discharge 002). The pH of Snow Creek ranged between 7.00 and 7.24 in 2002, and since pH measurements from 2007 were not available, the 2002 data was used for this analysis. Since there is a larger proportion of Snow Creek water in the Leavenworth NFH intake, there is reason to believe that the pH of the Leavenworth NFH discharge may have been different in 2007; however, the pH of the Leavenworth NFH discharge was also not measured in 2007, so the pH range from the 2002 TMDL study was used.

The model simulations predict there will be a pH changes greater than 0.1 pH units due to the Leavenworth NFH operations as currently configured (Figure 7). These changes are greater than the measurable change allowed by the water quality standard antidegradation rules.

A pH change in Icicle Creek above the Leavenworth NFH intake is expected due to the large inflow of lower pH Snow Creek water. After mixing with upstream water, the pH below the Snow Creek confluence is expected to lower 0.2 to 0.4 pH units. This is simply a change in the mass balance of hydrogen ion concentration from the mixing of lower pH Snow Creek water with upstream Icicle Creek water.



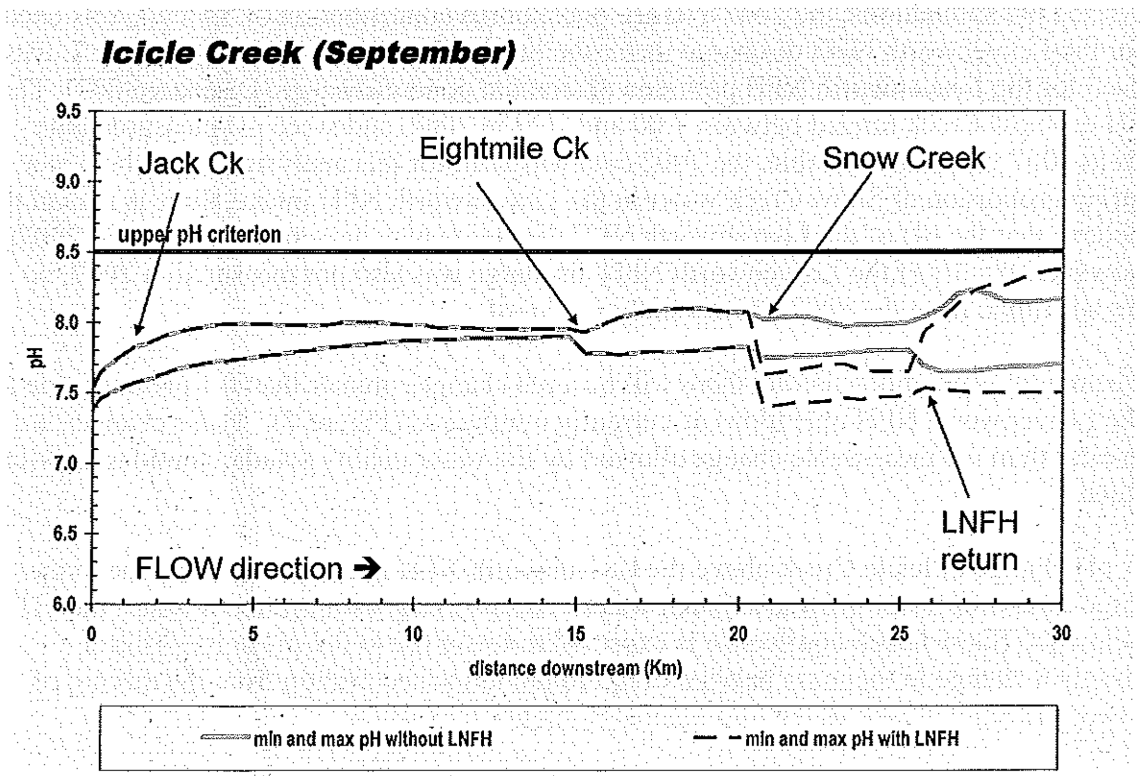


Figure 7. Simulated minimum and maximum pH in Icicle Creek with and without Leavenworth NFH operations for August and September flow conditions.

Similarly, at the Leavenworth NFH discharge mixing zone, a pH change is expected as the lower pH Leavenworth NFH discharge water mixes with the higher pH instream water. However, an increase in pH range further downstream of the Leavenworth NFH discharge is expected from increased productivity in that part of Icicle Creek that results from the additional phosphorus loading of the Leavenworth NFH discharges.

Fecal coliform bacteria and TSS/turbidity data were not modeled because the Icicle Creek model is not calibrated for those parameters. However, a review of the available data collected in 2002-03 shows that the Hatchery had no impact on downstream FC bacteria concentrations. Figure 8 shows fecal coliform data collected in 2002-03 in Icicle Creek. There were generally higher concentrations of FC bacteria below the Leavenworth NFH outfall at RM 3.0 than above, but the Leavenworth NFH outfall consistently had low concentrations (1-2 cfu/100mL) which suggest that the increases were not from the Hatchery operations. The Leavenworth NFH data included measurements in both the main outfall (Discharge 001) and the abatement pond discharge (Discharge 002).

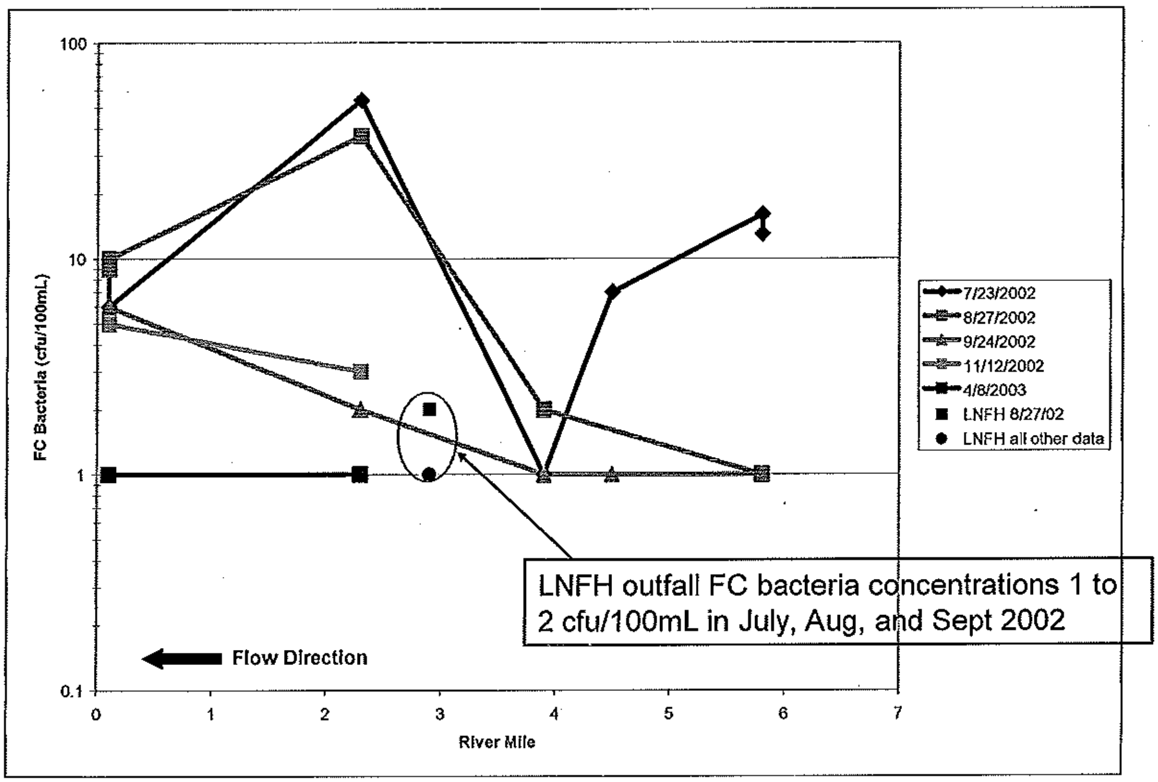


Figure 8. Fecal coliform bacteria concentrations by river mile in Icicle Creek from sampling done summer and fall of 2002 and April 2003. Concentrations of FC bacteria from the Leavenworth NFH outfall are also plotted at discharge point (RM3.0) in Icicle Creek.

Likewise, a review of the TSS data from 2002 shows the Leavenworth NFH had no impact on downstream TSS concentrations in Icicle Creek. Figure 9 shows TSS data collected in 2002-03 in Icicle Creek. There were generally higher concentrations of TSS below the Leavenworth NFH outfall (at RM 3.0) than above, but the Leavenworth NFH outfall consistently had a low TSS concentration below 1 mg/L (2 mg/L in June sample only) which suggest that the increases were not from the Hatchery operations. The Leavenworth NFH data included measurements in both the main outfall (Discharge 001) and the pollution abatement pond discharge (002).

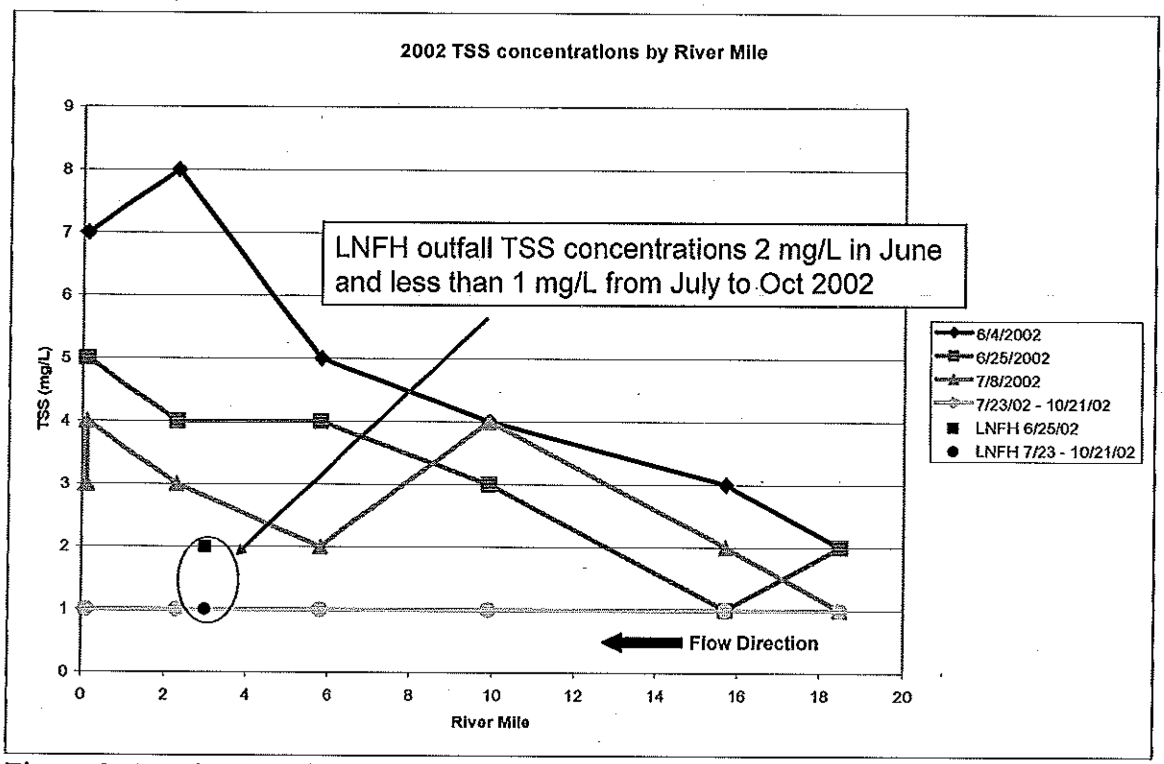


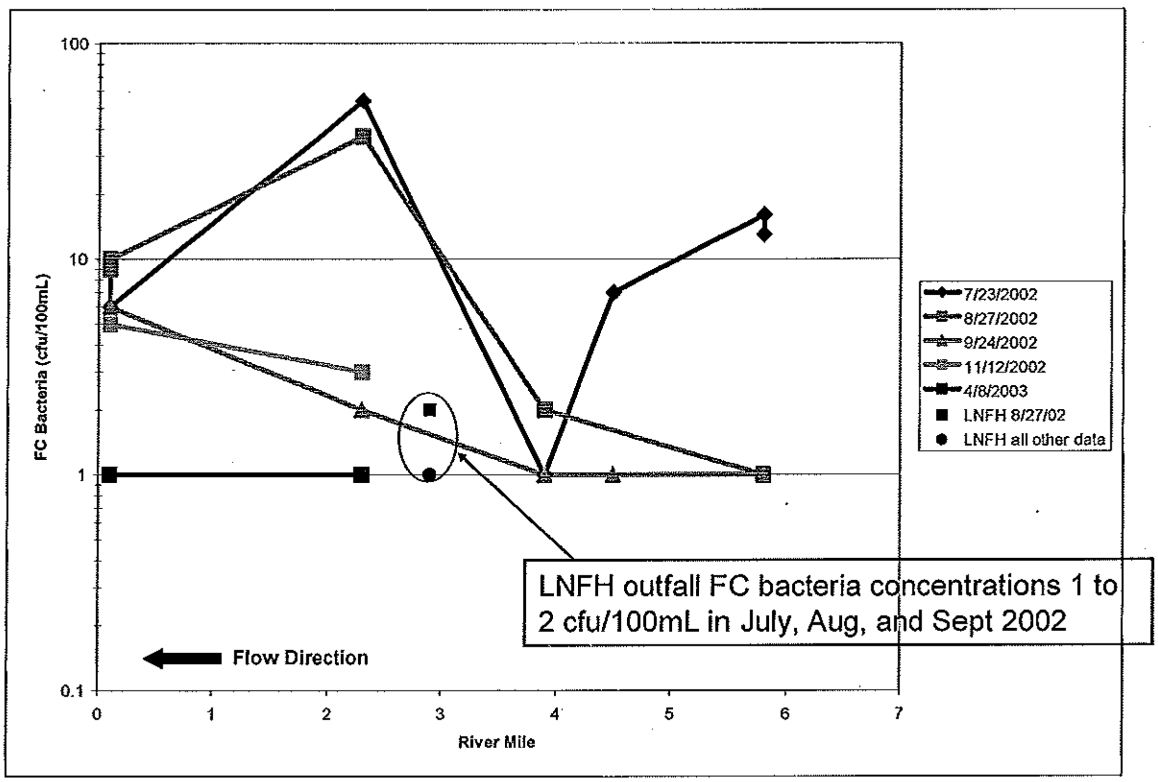
Figure 9. Total suspended solids concentrations by river mile in Icicle Creek from sampling done summer and fall of 2002. Concentrations of TSS from the Leavenworth NFH outfall are also plotted at discharge point (RM 3.0) in creek.

During higher runoff times (June and early July) there is a general increase in TSS concentrations going downstream from the headwaters. The average slope of the concentrations by river mile suggests an approximate 0.3 mg/L increase in TSS for each river mile of water transport. During lower flows from late July through October, the TSS levels were always at or below the reporting limit of 1.0 mg/L.

In terms of an antidegradation analysis regarding a change in turbidity caused by the Leavenworth NFH facility, the TSS results can be translated to turbidity results by the general relationship shown in Figure 10. This relationship shows that there is approximately a 0.26 NTU increase in turbidity for every 1.0 mg/L increase in TSS concentration. To keep actions from having a 0.5 NTU or greater measurable change in increased turbidity, increases in downstream TSS concentrations due to the Leavenworth NFH would need to be kept below 2 mg/L. Again, there is no indication that the Leavenworth NFH is causing any increase in downstream TSS concentrations.

Similarly, at the Leavenworth NFH discharge mixing zone, a pH change is expected as the lower pH Leavenworth NFH discharge water mixes with the higher pH instream water. However, an increase in pH range further downstream of the Leavenworth NFH discharge is expected from increased productivity in that part of Icicle Creek that results from the additional phosphorus loading of the Leavenworth NFH discharges.

Fecal coliform bacteria and TSS/turbidity data were not modeled because the Icicle Creek model is not calibrated for those parameters. However, a review of the available data collected in 2002-03 shows that the Hatchery had no impact on downstream FC bacteria concentrations. Figure 8 shows fecal coliform data collected in 2002-03 in Icicle Creek. There were generally higher concentrations of FC bacteria below the Leavenworth NFH outfall at RM 3.0 than above, but the Leavenworth NFH outfall consistently had low concentrations (1-2 cfu/100mL) which suggest that the increases were not from the Hatchery operations. The Leavenworth NFH data included measurements in both the main outfall (Discharge 001) and the abatement pond discharge (Discharge 002).



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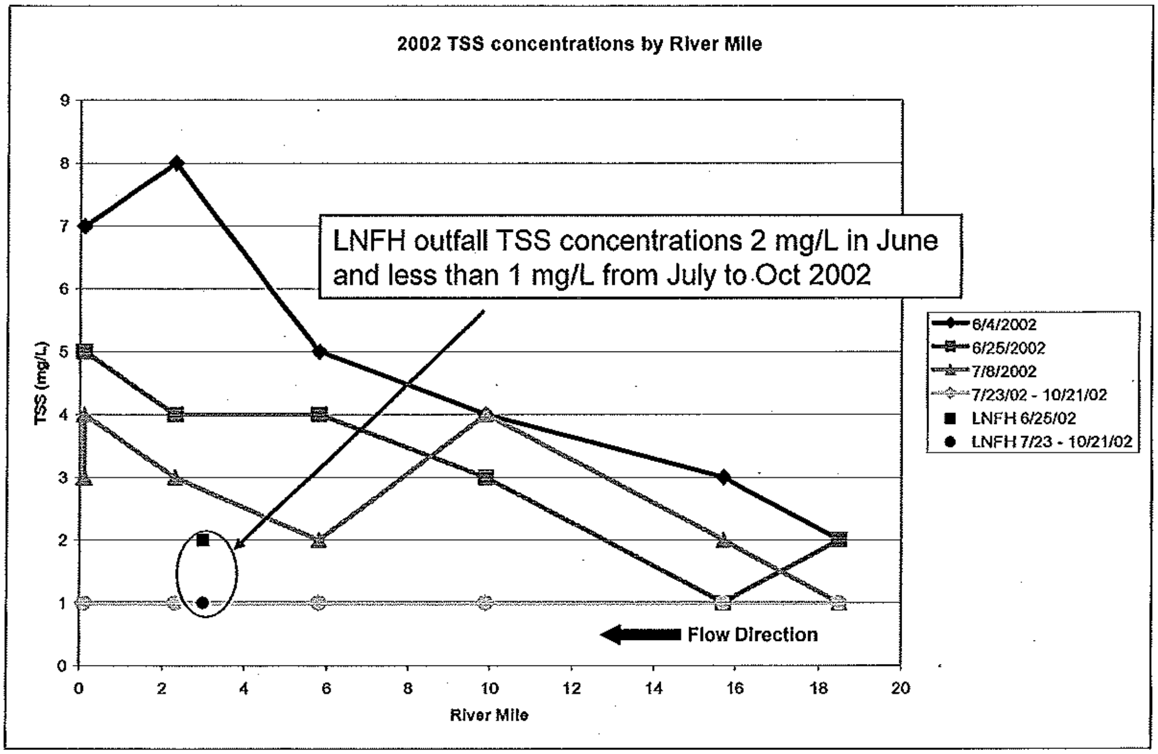

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During higher runoff times (June and early July) there is a general increase in TSS concentrations going downstream from the headwaters. The average slope of the concentrations by river mile suggests an approximate 0.3 mg/L increase in TSS for each river mile of water transport. During lower flows from late July through October, the TSS levels were always at or below the reporting limit of 1.0 mg/L.

In terms of an antidegradation analysis regarding a change in turbidity caused by the Leavenworth NFH facility, the TSS results can be translated to turbidity results by the general relationship shown in Figure 10. This relationship shows that there is approximately a 0.26 NTU increase in turbidity for every 1.0 mg/L increase in TSS concentration. To keep actions from having a 0.5 NTU or greater measurable change in increased turbidity, increases in downstream TSS concentrations due to the Leavenworth NFH would need to be kept below 2 mg/L. Again, there is no indication that the Leavenworth NFH is causing any increase in downstream TSS concentrations.

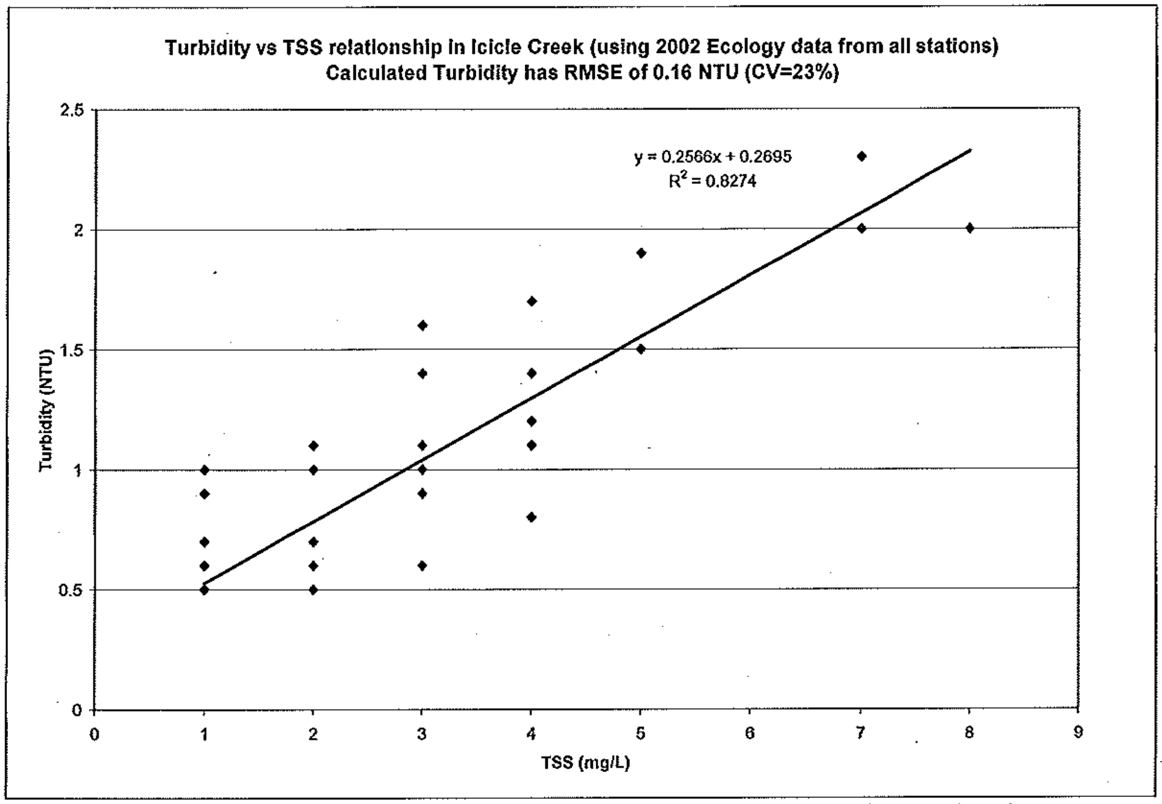

Figure 10. Turbidity and total suspended solids relationship in Icicle Creek using Ecology data from 2002 and 2003.

In summary, the Leavenworth NFH operations are expected to change the flow balance in lower Icicle Creek, particularly due to the managed addition of 50 cfs to Icicle Creek from Snow Creek. While improvements in water temperature and dissolved oxygen are expected from the Leavenworth NFH operations, model simulations predict there will be greater than a 0.1 unit change in pH due to the Leavenworth NFH operations. Available data from 2002 synoptic surveys did not show any downstream increase in fecal coliform bacteria or turbidity due to the Leavenworth NFH operations.

Toxic or Radio Active Substances

In 2005, the USFWS conducted a study to determine the extent of PCB and pesticide concentrations in Leavenworth NFH fish. In addition, the study assessed PCB and pesticide concentrations in Icicle Creek sediment above and below Leavenworth NFH, and in the pollution abatement pond. Data show that Leavenworth NFH is not adversely impacting the PCB or pesticide concentrations in Icicle Creek below the Hatchery (Tables 4 and 5 from USFWS 2005) and Hatchery fish are not accumulating PCB or pesticides to levels of concern (Tables 6 and 7 from USFWS 2005).

Table 4. Mean (max, number of detects) sediment concentration (µg/kg dry weight) found in sediments upstream of the hatchery intake, downstream of the hatchery effluent, and in the hatchery settling pond. Tetrachlorobenzene, DDE, DDD, DDT, and Hexachlorocyclohexane congeners were combined as the total tetrachlorobenzenes, total DDE, total DDD, total DDT, and total hexachlorocyclohexanes to reduce the number of compounds presented. Highlighted cells contain analyzed concentrations exceeding applicable benchmarks. Different superscript letters for each compound indicate significant differences ($\alpha = 0.05$; USFWS 2005).

Contaminant	Applicable benchmark[1]	Upstream of Hatchery intake	Downstream of Hatchery effluent	In Hatchery settling pond
Total PCB	60	5.16 (13.8, 5)[a]	5.38 (12.1, 5)[a]	**69.3 (147, 5)**[b]
Aroclor 1242	100	<0.42 (-, 0)[a]	<0.38 (-, 0)[a]	5.3 (22.1, 1)[b]
Aroclor 1248	21	<0.42 (-, 0)	<0.38 (-, 0)	<1.1 (-, 0)
Aroclor 1254	230	<0.42 (-, 0)	<0.38 (-, 0)	<1.1 (-, 0)
Aroclor 1260	138	<0.42 (-, 0)[a]	<0.38 (-, 0)[a]	25.9 (125, 1)[b]
Aroclor 1268	N/A	<0.42 (-, 0)	<0.38 (-, 0)	<1.1 (-, 0)
Toxaphene	1.5	<0.04 (-, 0)	<0.04 (-, 0)	<0.11 (-, 0)
Tetrachlorobenzene	N/A	0.85 (2.77, 5)[a]	0.62 (1.15, 5)[a]	2.63 (5.18, 5)[b]
Pentachlorobenzene	N/A	0.08 (0.22, 1)[ab]	<0.04 (-, 0)[a]	<0.11 (-, 0)[b]
Hexachlorobenzene	20	0.09 (0.25, 1)[a]	<0.04 (-, 0)[a]	0.50 (0.91, 4)[b]
Hexachlorocyclohexanes	3	0.44 (1.21, 3)[ab]	0.18 (0.29, 2)[a]	2.17 (**4.04**, 5)[b]
Beta Hexachlorocyclohexane	5	0.14 (0.53, 1)[a]	<0.04 (-, 0)[a]	1.62 (3.74, 5)[b]
Chlordane-related sum	3.2	0.49 (1.31, 2)[ab]	0.28 (0.38, 1)[a]	1.12 (1.33, 4)[b]
Heptachlor	0.3	0.05 (0.09, 1)[a]	0.05 (0.10, 1)[a]	0.20 (0.29, 3)[b]
Heptachlor Epoxide	0.6	0.08 (0.27, 1)[ab]	<0.04 (-, 0)[a]	0.27 (0.54, 3)[b]
Oxychlordane	N/A	<0.04 (-, 0)	<0.04 (-, 0)	<0.11 (-, 0)
Alpha Chlordane	N/A	<0.04 (-, 0)[a]	<0.04 (-, 0)[a]	0.22 (0.43, 2)[b]
Gamma Chlordane	N/A	0.12 (0.46, 1)[ab]	<0.04 (-, 0)[a]	<0.11 (-, 0)[b]
Cis-Nonachlor	N/A	0.10 (0.35, 1)[ab]	<0.04 (-, 0)[a]	<0.11 (-, 0)[b]
Trans-Nonachlor	N/A	<0.04 (-, 0)	<0.04 (-, 0)	<0.11 (-, 0)
Aldrin	2	0.16 (0.24, 4)[a]	0.09 (0.15, 4)[a]	<0.11 (-, 0)[a]
Dieldrin	1.9	<0.04 (-, 0)[a]	<0.04 (-, 0)[a]	0.15 (0.29, 1)[b]
Endrin	2.2	<0.04 (-, 0)[a]	0.05 (0.10, 1)[a]	0.75 (**2.24**, 4)[b]
Pentachloroanisole	N/A	0.24 (0.59, 3)[ab]	0.09 (0.21, 2)[a]	0.54 (1.21, 4)[b]
Chlorpyrifos	N/A	<0.04 (-, 0)[a]	<0.04 (-, 0)[a]	0.19 (0.51, 1)[b]
Mirex	7	<0.04 (-, 0)[a]	0.06 (0.14, 1)[a]	1.72 (3.30, 5)[b]
Endosulfan II	N/A	0.07 (0.19, 1)[a]	0.17 (0.40, 2)[a]	0.26 (0.40, 3)[a]
DDE	21	0.13 (0.31, 1)[a]	0.12 (0.34, 1)[a]	2.63 (3.28, 5)[b]
DDD	96	0.12 (0.31, 1)[a]	<0.08 (-, 0)[a]	0.66 (1.49, 3)[b]
DDT	19	0.23 (0.40, 4)[a]	0.39 (1.0, 3)[ab]	0.71 (1.10, 5)[b]

1. Applicable benchmarks were identified from the literature. Preference was given to Washington Department of Ecology interpretation of Apparent Effect Thresholds (Ecology 2003).

Table 5. Mean (max, number of detects) sediment concentration (µg/kg dry weight, normalized to 1% organic carbon concentration) found in sediments upstream of the hatchery intake, downstream of the hatchery effluent, and in the hatchery settling pond. Tetrachlorobenzene, DDE, DDD, DDT, and Hexachlorocyclohexane congeners were combined to reduce the number of compounds presented. Highlighted cells contain analyzed concentrations exceeding applicable benchmarks. Different superscript letters for each compound indicate significant differences ($\alpha = 0.05$; USFWS 2005).

Contaminant	**Applicable benchmark**[1]	**Upstream of Hatchery intake**	**Downstream of Hatchery effluent**	**In Hatchery settling pond**
Total PCB	70	13.0 (10.6, 5)[a]	11.5 (16.0, 5)[ab]	24.8 (64.0, 5)[b]
Aroclor 1242		<1.40 (-, 0)[a]	<1.33 (-, 0)[a]	2.19 (9.60, 1)[a]
Aroclor 1248	600	<1.40 (-, 0)	<1.33 (-, 0)	<0.36 (-, 0)
Aroclor 1254	195	<1.40 (-, 0)	<1.33 (-, 0)	<0.36 (-, 0)
Aroclor 1260	200	<1.40 (-, 0)[a]	<1.33 (-, 0)[a]	11.2 (54.4, 1)[a]
Aroclor 1268		<1.40 (-, 0)	<1.33 (-, 0)	<0.36 (-, 0)
Toxaphene	0.1	<0.14 (-, 0)	<0.13 (-, 0)	<0.04 (-, 0)
Tetrachlorobenzene	46	2.64 (8.15, 5)[a]	1.77 (2.54, 5)[a]	0.95 (2.25, 5)[a]
Pentachlorobenzene	690	0.19 (0.30, 1)[ab]	<0.13 (-, 0)[a]	<0.04 (-, 0)[b]
Hexachlorobenzene	100	0.27 (0.75, 2)[a]	<0.13 (-, 0)[a]	0.18 (0.40, 4)[a]
Hexachlorocyclohexanes	0.6	**1.23 (3.57,** 3)[a]	0.57 (**0.78**, 2)[a]	**0.82 (1.76,** 5)[a]
Beta Hexachlorocyclohexane	200	0.42 (1.57, 1)[a]	<0.13 (-, 0)[a]	0.62 (1.63, 5)[a]
Chlordane-related sum	0.3	**1.52 (3.85,** 2)[a]	**1.00 (1.46,** 1)[a]	**0.39 (0.56,** 4)[a]
Heptachlor	1.0	0.15 (0.30, 1)[a]	0.20 (0.48, 1)[a]	0.07 (0.12, 3)[a]
Heptachlor Epoxide	1.0	0.27 (0.80, 1)[a]	<0.13 (-, 0)[a]	0.10 (0.23, 3)[a]
Oxychlordane		<0.14 (-, 0)	<0.13 (-, 0)	<0.04 (-, 0)
Alpha Chlordane		<0.14 (-, 0)[a]	<0.13 (-, 0)[a]	0.07 (0.15, 2)[a]
Gamma Chlordane		0.38 (1.35, 1)[a]	<0.13 (-, 0)[a]	<0.04 (-, 0)[b]
Cis-Nonachlor		0.31 (1.02, 1)[a]	<0.13 (-, 0)[a]	<0.04 (-, 0)[b]
Trans-Nonachlor		<0.14 (-, 0)	<0.13 (-, 0)	<0.04 (-, 0)
Aldrin	2	0.68 (**2.14**, 4)[a]	0.33 (0.59, 4)[a]	<0.04 (-, 0)[b]
Dieldrin	1.3	<0.14 (-, 0)[a]	<0.13 (-, 0)[a]	0.05 (0.13, 1)[b]
Endrin	8	<0.14 (-, 0)[a]	0.20 (0.49, 1)[a]	0.31 (0.98, 4)[a]
Pentachloroanisole		0.57 (1.74, 3)[a]	0.19 (0.22, 2)[a]	0.20 (0.53, 4)[a]
Chlorpyrifos	32	<0.14 (-, 0)[a]	<0.13 (-, 0)[a]	0.06 (0.17, 1)[b]
Mirex	7	<0.14 (-, 0)[a]	0.15 (0.20, 1)[a]	0.68 (1.43, 5)[a]
Endosulfan II	0.3	0.18 (**0.30**, 1)[ab]	0.32 (**0.70**, 2)[a]	0.08 (0.17, 3)[b]
DDE	50	0.34 (0.59, 1)[a]	0.31 (0.39, 1)[a]	0.83 (1.43, 5)[b]
DDD	60	0.39 (0.90, 1)[a]	<0.27 (-, 0)[a]	0.15 (0.39, 3)[a]
DDT	1.5	0.59 (1.17, 4)[a]	0.75 (1.15, 3)[a]	0.27 (0.48, 5)[b]

1. Applicable benchmarks were identified from the literature. The lowest available 1% organic carbon benchmark or criteria was used as the applicable benchmark.

Table 6. Mean (max, number of detects) whole-body fish tissue concentration (μg/kg wet weight) found in chinook salmon reared at the hatchery. Tetrachlorobenzene, DDE, DDD, DDT, and Hexachlorocyclohexane congeners were combined to reduce the number of compounds presented. Highlighted cells contain analyzed concentrations exceeding applicable benchmarks. Different superscript letters for each compound indicate significant differences ($\alpha = 0.05$; USFWS 2005).

Contaminant	Applicable benchmark[1]	Fry from fiberglass raceways	Fry from painted raceways	Pre-smolt
Total PCB	110	17.6 (26.4, 6)^{a}	20.0 (35.7, 6)^{ab}	31.7 (48.3, 6)^{b}
Aroclor 1242		<1.05 (-, 0)^{a}	<1.22 (-, 0)^{a}	2.04 (9.67, 1)^{a}
Aroclor 1248		<1.05 (-, 0)^{a}	2.13 (7.14, 1)^{a}	4.67 (16.3, 2)^{a}
Aroclor 1254		<1.05 (-, 0)^{a}	2.72 (10.7, 1)^{a}	8.62 (28.0, 2)^{a}
Aroclor 1260		<1.05 (-, 0)^{a}	3.91 (17.9, 1)^{a}	1.94 (7.25, 2)^{a}
Aroclor 1268		<1.05 (-, 0)^{a}	<1.22 (-, 0)^{a}	<0.51 (-, 0)^{b}
Toxaphene	6.3	<0.12 (-, 0)	<0.12 (-, 0)	<0.05 (-, 0)
Tetrachlorobenzene	3200	0.31 (0.58, 1)^{a}	0.42 (0.85, 4)^{ab}	0.71 (1.13, 6)^{b}
Pentachlorobenzene	8600	<0.12 (-, 0)^{a}	0.36 (0.49, 5)^{b}	0.42 (0.71, 6)^{b}
Hexachlorobenzene	200	0.36 (0.38, 6)^{a}	0.37 (0.46, 6)^{a}	0.73 (0.91, 6)^{b}
Hexachlorocyclohexanes	100	<0.50 (-, 0)^{a}	<0.49 (-, 0)^{a}	0.25 (0.38, 3)^{b}
Beta Hexachlorocyclohexane	60	<0.12 (-, 0)^{a}	<0.12 (-, 0)^{a}	0.09 (0.23, 2)^{a}
Chlordane-related sum	370	1.32 (1.62, 6)^{a}	1.33 (1.61, 6)^{a}	1.26 (2.06, 6)^{a}
Heptachlor	200	<0.12 (-, 0)^{a}	<0.12 (-, 0)^{a}	0.15 (0.62, 1)^{a}
Heptachlor Epoxide	200	<0.12 (-, 0)	<0.12 (-, 0)	<0.05 (-, 0)
Oxychlordane		<0.12 (-, 0)	<0.12 (-, 0)	0.06 (0.12, 1)
Alpha Chlordane		0.25 (0.38, 4)^{a}	0.23 (0.29, 4)^{a}	0.23 (0.42, 5)^{a}
Gamma Chlordane		<0.12 (-, 0)^{a}	<0.12 (-, 0)^{a}	0.16 (0.30, 5)^{a}
Cis-Nonachlor		<0.12 (-, 0)^{ab}	<0.12 (-, 0)^{a}	0.19 (0.23, 5)^{b}
Trans-Nonachlor		0.47 (0.51, 6)^{a}	0.49 (0.60, 6)^{a}	0.43 (0.64, 5)^{a}
Aldrin	22	<0.12 (-, 0)^{a}	<0.12 (-, 0)^{ab}	0.07 (0.15, 1)^{b}
Dieldrin	22	<0.12 (-, 0)^{a}	<0.12 (-, 0)^{a}	0.24 (0.39, 6)^{b}
Endrin	25	<0.12 (-, 0)^{a}	<0.12 (-, 0)^{a}	0.16 (0.54, 3)^{a}
Pentachloroanisole		0.22 (0.27, 5)^{a}	0.23 (0.29, 4)^{a}	1.71 (2.03, 6)^{b}
Chlorpyrifos		<0.12 (-, 0)^{ab}	<0.12 (-, 0)^{a}	0.28 (0.55, 5)^{b}
Mirex	370	<0.12 (-, 0)	<0.12 (-, 0)	<0.05 (-, 0)
Endosulfan II	6500	<0.12 (-, 0)	<0.12 (-, 0)	<0.05 (-, 0)
Sum all DDT	14	8.71 (9.74, 6)^{a}	9.39 (11.3, 6)^{ab}	10.9 (13.7, 6)^{b}
DDE	200	7.14 (7.80, 6)^{a}	7.79 (9.22, 6)^{ab}	8.63 (10.6, 6)^{b}
DDD	200	1.08 (1.31, 6)^{a}	1.06 (1.39, 6)^{a}	1.44 (1.94, 6)^{a}
DDT	200	0.50 (0.63, 6)^{a}	0.54 (0.66, 6)^{a}	0.79 (1.21, 6)^{a}

1. Applicable benchmarks were identified from the literature. Whole-fish benchmarks were preferred over edible portions benchmarks.

Table 7. Mean (max, number of detects) whole-body fish tissue concentration (µg/kg lipid) found in chinook salmon reared at the hatchery. Tetrachlorobenzene, DDE, DDD, DDT, and Hexachlorocyclohexane congeners were combined to reduce the number of compounds presented. Highlighted cells contain analyzed concentrations exceeding applicable benchmarks. Different superscript letters for each compound indicate significant differences ($\alpha = 0.05$; USFWS 2005).			
Contaminant	**Fry from fiberglass raceways**	**Fry from painted raceways**	**Pre-smolt**
Total PCB	546 (790, 6)[a]	601 (1021, 6)[a]	749 (1147, 6)[a]
Aroclor 1242	<33.6 (-, 0)[a]	<37.1 (-, 0)[a]	45.8 (209, 1)[a]
Aroclor 1248	<33.6 (-, 0)[a]	63.2 (204, 1)[a]	97.9 (323, 2)[a]
Aroclor 1254	<33.6 (-, 0)[a]	80.2 (306, 1)[a]	180 (554, 2)[a]
Aroclor 1260	<33.6 (-, 0)[a]	114 (511, 1)[a]	43.0 (157, 2)[a]
Aroclor 1268	<33.6 (-, 0)[a]	<37.1 (-, 0)[a]	<12.8 (-, 0)[b]
Toxaphene	<3.9 (-, 0)	<3.7 (-, 0)	<1.3 (-, 0)
Tetrachlorobenzene	9.8 (19.5, 1)[a]	12.9 (24.3, 4)[ab]	12.1 (23.6, 6)[b]
Pentachlorobenzene	<3.9 (-, 0)[a]	10.8 (14.2, 5)[b]	5.5 (11.6, 3)[b]
Hexachlorobenzene	11.2 (12.2, 6)[a]	11.1 (13.1, 6)[a]	17.6 (35.2, 6)[b]
Hexachlorocyclohexanes	15.5 (-, 0)[a]	14.8 (-, 0)[a]	6.1 (9.9, 3)[b]
Beta Hexachlorocyclohexane	<3.9 (-, 0)[a]	<3.7 (-, 0)[ab]	2.2 (5.0, 2)[b]
Chlordane-related sum	41.3 (53.3, 4)[a]	40.3 (46.3, 6)[a]	34.9 (96.7, 6)[a]
Heptachlor	<3.9 (-, 0)[a]	<3.7 (-, 0)[a]	5.7 (29.2, 1)[a]
Heptachlor Epoxide	<3.9 (-, 0)	<3.7 (-, 0)	<1.3 (-, 0)
Oxychlordane	<3.9 (-, 0)[a]	<3.7 (-, 0)[a]	1.5 (2.5, 1)[b]
Alpha Chlordane	7.8 (11.6, 4)[a]	6.9 (8.6, 4)[a]	6.1 (15.3, 5)[a]
Gamma Chlordane	<3.9 (-, 0)[a]	<3.7 (-, 0)[a]	4.2 (9.3, 5)[a]
Cis-Nonachlor	<3.9 (-, 0)[a]	<3.7 (-, 0)[a]	4.8 (10.9, 5)[a]
Trans-Nonachlor	14.7 (17.2, 6)[a]	14.8 (17.3, 6)[a]	11.3 (27.0, 5)[a]
Aldrin	<3.9 (-, 0)[a]	<3.7 (-, 0)[a]	1.7 (3.6, 1)[b]
Dieldrin	<3.9 (-, 0)[a]	<3.7 (-, 0)[a]	6.6 (18.1, 6)[a]
Endrin	<3.9 (-, 0)[a]	<3.7 (-, 0)[a]	3.7 (11.8, 3)[a]
Pentachloroanisole	7.0 (9.2, 5)[a]	7.0 (9.0, 4)[a]	40.2 (65.1, 6)[b]
Chlorpyrifos	<3.9 (-, 0)[a]	<3.7 (-, 0)[a]	6.6 (12.0, 5)[a]
Mirex	<3.9 (-, 0)	<3.7 (-, 0)	<1.3 (-, 0)
Endosulfan II	<3.9 (-, 0)	<3.7 (-, 0)	<1.3 (-, 0)
Sum all DDT	274 (316, 6)[a]	284 (322, 6)[a]	268 (516, 6)[a]
DDE	224 (262, 6)[ab]	236 (264, 6)[a]	213 (406, 6)[b]
DDD	33.9 (42.3, 6)[a]	32.0 (39.8, 6)[a]	36.0 (73.7, 6)[a]
DDT	15.7 (18.9, 6)[a]	16.2 (18.9, 6)[a]	19.4 (36.5, 6)[a]

AKART Analysis
Described below are the known, available, and reasonable methods of prevention, control, and treatment which Leavenworth NFH performs to minimize impacts to the water quality in Icicle Creek. The structural and operation items described represent the most current methodology that are reasonably required for preventing, controlling, or abating the pollutants associated with Leavenworth NFH's effluent discharge.

Pollution Abatement Pond/Sand Settling Basin
In 1979, Leavenworth NFH constructed a pollution abatement pond to meet the terms and conditions of the NPDES permit. In 1995, the pollution abatement pond was enlarged to incorporate all rearing units and to increase the amount of time particulate matter had to settle. Features were also added to facilitate cleaning the pond. Effluent water quality also benefited with the addition of the sand settling basin which was also constructed in 1995. The sand settling basin removes sediment which would otherwise settle in the fish rearing units or the pollution abatement pond and makes the pollution abatement pond more effective at removing fish wastes as apposed to settling river sediment.

Sediment analysis done in 2006 and 2007 showed phosphorus levels of 114 and 2,990 ppm which are considered excessive, suggesting the pollution abatement pond is reducing nutrient load in the discharge water by capturing a significant portion of the excreted fecal phosphorus produced by the fish. Total suspended solids and settable solids samples from the pollution abatement pond have not exceeded NPDES discharge limits.

The pollution abatement pond is periodically dewatered to facilitate removal of the accumulated sediment. The material is composed primarily of stream sediment, detritus, fish waste and a small portion of unused fish feed. Pond cleaning is coordinated with the Chelan Douglas Health Department and in April 2007, Hatchery personnel removed an estimated 300 cubic yards of accumulated material from the pollution abatement pond which was provided to a local farmer for agricultural application.

Pesticide/Fertilizer Use
Leavenworth NFH uses integrated pest management to control pests and noxious weeds on the 160 acres of land adjacent to Icicle Creek. A key component of the program is eliminating the use of chemical pesticides to control noxious weeds. Instead, noxious weeds are controlled by mowing, allowing goats to eat the weeds, biological agents which disrupt seed production, and/or hand pulling the weeds.

Fish Food
In August 2005, Ecology found the level of phosphorus in the water discharged from the Hatchery at 13 parts per billion (ppb; Carroll et al, 2006). Entering the three critical summer months of July, August and September 2007, the Hatchery switched to a low phosphorus feed with the expectation that phosphorus levels in the discharge water would be significantly reduced. Low phosphorus feed typically contains about half the phosphorus as regular feed. To monitor the phosphorus levels, the Hatchery developed a sampling plan and collected samples at the point of diversion from Icicle Creek, at the base of the adult pond fish ladder (Discharge 001), at the point of discharge from the

pollution abatement pond (Discharge 002), at structure 5, and the Hatchery wells. Also, for accuracy of water analysis, all samples were sent to the Washington Manchester Laboratory to determine phosphorus levels, along with settleable solid, and suspended solid levels. Lab results showed the levels of phosphorus in the Hatchery discharge water to be at the lower end of the 5 to 10 ppb range. Of particular importance was the sampling done towards the end of September when stream flows are at their lowest. The weighted or proportional level of phosphorus for the two discharge points was 6.5 ppb (Tiedman 2007). Leavenworth NFH will continue to use low phosphorus feed during the critical summer months.

Within the past 10-15 years, fish feeds for salmon have evolved, and extruded feeds are currently being used at Leavenworth NFH as opposed to pelleted feeds. The cooking process involved in making extruded feeds makes them more digestible, and therefore, less fish waste is produced. In addition, extrusion makes a more durable pellet, so there are fewer fine particles to foul the water (Barrows and Hardy 2002).

The improvement of fish feed quality is ongoing. In 2008, the National Oceanic and Atmospheric Administration and the US Department of Agriculture began the Alternative Feeds Initiative to assess issues and identify opportunities to explore alternative ingredients that warrant support through research and development, testing, and commercialization. One key component this initiative will address is environmental implications of the feed product.

Snow/Nada Lakes Water Release

Starting in 2004, Leavenworth NFH began taking a closer look at how best to utilize the resources in Snow/Nada Lakes to benefit Hatchery operations and minimize impacts on Icicle Creek water quality and quantity. Recent reports by Wurster (2006) and Montgomery Water Group (2004) describe water use from the reservoirs. Both reports indicate that in most years the reservoirs are capable of providing the Hatchery's full water right (42 cfs) from approximately late July to October with a reasonable expectation of refilling the withdrawn amount by July of the following year. Prior to 2005, water released from Snow/Nada Lakes averaged around 25 cfs from late July to early October. In 2006 and 2007, water releases averaged in the upper 40 cfs during the same time period. Leavenworth NFH is continuing to work with USFWS hydrologists to more effectively utilize the available water resources to benefit Hatchery operations and minimize impacts to Icicle Creek water quality and quantity. This potentially includes discharging more flow incrementally from the lakes as Icicle Creek flows naturally decline in late summer.

Prior to the changes incorporated in 2006, the Hatchery had difficultly maintaining adequate flow through the rearing units during low instream flow periods. Now the amount of water released from the lakes improves flow through the Hatchery and benefits fish health. The improved flow to the Hatchery during the summer is essential as well water availability, particularly in the shallow water wells, is minimal at this time of year. Additionally, water discharges from the Snow/Nada Lakes also benefit Icicle Creek by increasing instream flow, decreasing water temperature, increasing dissolved oxygen concentration and reducing pH (see the Current Effects of Leavenworth NFH on Icicle Creek Water Quality section).

Reduction in Fish Production
Another factor improving the quality of the Hatchery's water discharge has been a reduction in the number and pounds of fish the Hatchery produces each year. When the spring Chinook salmon program started in 1974, the production target was to release 2.2 million pre-smolts annually. In 1993, the Hatchery reduced the spring Chinook salmon program to target a release of 1.625 million fish as a means to improve fish health while on station and increase contribution rates to various harvest sectors. As a result, the total pounds produced decreased from approximately 122,000 to 92,000. The Hatchery again has plans to lower the number of fish being reared starting in 2008 and is awaiting approval from parties associated with U.S. v. Oregon, the group that sets production targets for the Columbia River Basin. The target for Leavenworth NFH is expected to be 1.2 million spring Chinook salmon produced annually or about 71,000 pounds.

Currently, Leavenworth NFH supports the Yakama Nation's Coho Salmon Reintroduction Project by providing rearing space for approximately 750,000 coho salmon pre-smolts that are acclimated on station for approximately two to four months prior to release in late April. Coho salmon gain approximately 10-15,000 pounds while reared at Leavenworth NFH. In 2007, the two programs produced approximately 81,000 pounds of spring Chinook salmon and 11,000 pounds of coho salmon (weight gain while on station).

Other species have been reared at the Hatchery through the years. On an annual basis Spring Chinook salmon have accounted for the largest number of fish and pounds produced compared to other species since 1974.

Hatchery Reform
In October 2005, the USFWS initiated a three-year review of 21 salmon and steelhead hatcheries that the USFWS owns or operates in the Columbia River Basin. The review of Leavenworth NFH occurred in 2007. The goal of the USFWS's review is to ensure that all federal hatcheries are operated in accordance with best scientific principles, and contribute to sustainable fisheries and the conservation of naturally-spawning populations of salmon, steelhead and other aquatic species. Some of the recommendations the Hatchery Review Team made for Leavenworth NFH are expected to improve water quality in Icicle Creek. For example reducing the rearing densities of juvenile spring Chinook salmon by 25% (see *Reduction in Fish Production*) will also reduce the amount of fish waste produced, and improvements to the water delivery system could improve instream flow which would benefit water quality.

Toxic or Radio Active Substances
In 2004, Ecology analyzed the paint on fish rearing troughs at Leavenworth NFH and an elevated level of PCB was found (WDOE 2004). All those troughs were removed and disposed of properly in 2005.

Turbidity
The Leavenworth NFH intake system and withdrawal of 42 cfs year-round do not increase the sediment input into Icicle Creek or affect factors which contribute to sedimentation. Sampling results indicate Leavenworth NFH meets all NPDES permit requirements.

When making adjustments to the intake diversion dam or fish ladder and/or structures 2 and 5, Leavenworth NFH staff collect water samples to measure nephelometric turbidity units (NTU) to document compliance with *Water Quality Standards for Surface Waters WAC 173-201A*. The information recorded includes sampling location, date, time, investigator, NTU, field conditions (weather, temperature, other in-river disturbances) and any other informational comments. The most recent adjustment and current setting for structures 2 and 5 are also described when samples are collected.

Two background water samples are collected prior to making an adjustment to any of the structures: one less than one hundred feet upstream and the other less than three hundred feet downstream of the structure being adjusted. The specific sample sites provide safe access through a range of flows. For adjustments made to structures 2 and 5, all sites are located within the historic channel of Icicle Creek. Water samples are collected as close to the center of the water body as possible and the downstream site is sampled first to avoid contamination.

Additional water samples from both the upstream and downstream location are collected one hour after the adjustment. If sampling results indicate non-compliance with water quality standards, actions are implemented to remedy the situation. Water samples continue until compliance is achieved. The results, duration of the non-compliance issue, time of day, and characteristics of the activity causing the non-compliance are noted. Compliance criteria indicate that turbidity shall not exceed 5 NTUs above background when the background is 50 NTUs or less, or when the background turbidity is greater than 50 NTU, a 10 percent increase in turbidity is considered compliant. Gary Graff of the Ecology (Yakima Office) is contacted when compliance is not achieved.

The turbidity meter is used according to the manufacturer's recommendations and calibrated according to their specified scheduled. Information on when the equipment was calibrated is recorded. Additional calibration is performed if data appears suspect. Variation from the standard procedures may be required depending on exact field conditions and other project considerations. All procedures are outlined on a one-page monitoring protocol for staff.

Real time results guide the rate or method of adjustments to structures 2 and 5 and the intake diversion dam and fish ladder. All data forms, maps and pictures of the sampling stations are stored in a single file at the Leavenworth NFH for easy access for compliance inspections or peer review of the documentation. Data collected in the field is entered into an Excel spreadsheet for reporting and analysis. Information is forwarded to Gary Graff of the Washington Department of Ecology semi-annually (January and June).

Necessity of Leavenworth National Fish Hatchery

Grand Coulee Mitigation

The hatcheries of the Leavenworth National Fish Hatchery Complex, consisting of Leavenworth NFH, Entiat NFH and Winthrop NFH began operations in 1938, 1940 and 1940, respectively. Reclamation built the hatcheries, but the Bureau of Fisheries (now the USFWS) funded and operated them until 1993 when Reclamation began directly reimbursing the USFWS for their operation. The impetus for their construction was to perpetuate the anadromous fish runs that were displaced from the natural spawning areas above Grand Coulee Dam. The hatcheries were initially authorized under the Grand Coulee Dam Project, 49 Statute 1028, on August 30, 1935 as part of the Rivers and Harbors Act. The hatcheries were reauthorized under the Columbia Basin Project Act, 57 Statute 14, on March 10, 1943, and subsequently under the Fish and Wildlife Coordination Act, 60 Statute 1080, on August 14, 1946. The adult salmon and steelhead runs were first intercepted at Rock Island Dam beginning in 1939 and continuing through the returns in 1943 as part of the Grand Coulee Fish Maintenance Project (GCFMP). The initial program consisted of direct outplants of adult fish to specific stream areas and beginning in 1940, Hatchery production. Fish production has been continuous since 1940.

The mitigation objectives commonly associated with the GCFMP are:

1) "to bring by stream rehabilitation and supplemental planting the fish populations in the 677 miles of tributary streams below Grand Coulee and Rock Island Dam up to figures commensurate with the earlier undisturbed conditions and with the natural food supply in these streams."

2) "to produce in addition, by combination of artificial spawning, hatching, feeding, rearing and planting in these streams, a supplemental downstream migration equivalent to that normally produced by the 1,140 miles of streams and tributaries above Grand Coulee Dam."

Tribal Trust

Trust Responsibilities to Native American Tribes are described by the Indian Trust Doctrine, which was developed by the US Supreme Court. The doctrine articulates the trust responsibility that the Federal Government has in relation to Native Americans. The Federal Government has fiduciary obligations to the Tribes- in essence, a legal obligation to act in the Tribe's best interests, including duties to protect Tribal lands and cultural and natural resources.

Under the Secretarial Order 3206 (signed by both the Secretary of the Interior and the Secretary of Commerce), *American Indian Tribal Rights, Federal-Tribal Trust Responsibilities*, it is further recognized the USFWS (including Leavenworth NFH) has trust responsibilities with respect to tribes. The one tribe which Leavenworth NFH has the greatest interaction with is the Yakama Nation. Adult salmon returning to the Hatchery are an important component of the Yakama Nation's fisheries activities. Since 1987, the Yakama Nation has exercised its treaty right to fish for spring Chinook salmon in Icicle Creek. The focus of the fishery is the large pool located below the Leavenworth

NFH spillway; the character of the river here provides access to construct scaffolds, and fishing platforms. The fishery is important to tribal members as one of the few remaining places in Washington State that offers a productive fishing opportunity utilizing traditional methods. Salmon continue to be an important nutritional and symbolic commodity of the Yakama Nation.

The Yakama Nation is a member of an organization called the Columbia River Inter-Tribal Fish Commission (CRITFC) which also includes the Warm Springs, Umatilla, and Nez Perce tribes. CRITFC serves to manage and protect fisheries resources in the Columbia River basin and protect treaty fishing rights. CRITFC explains the importance of salmon to Tribes in the following way:

Salmon play an integral part of tribal religion, culture, and physical sustenance. Listed below is a short list of the many ways that the tribes consider the salmon to be sacred.

- *Salmon are part of our spiritual and cultural identity.*
- *Over a dozen longhouses and churches on the reservations and in ceded areas rely on salmon for their religious services.*
- *The annual salmon return and its celebration by our peoples assure the renewal and continuation of human and all other life.*
- *Historically, we were wealthy peoples because of a flourishing trade economy based on salmon.*
- *For many tribal members, fishing is still the preferred livelihood.*
- *Salmon and the rivers they use are part of our sense of place. The Creator put us here where the salmon return. We are obliged to remain and to protect this place.*
- *Salmon are indicator species: As water becomes degraded and fish populations decline, so too will the elk, deer, roots, berries and medicines that sustain us.*
- *As primary food source for thousands of years, salmon continue to be an essential aspect of our nutritional health.*
- *Because our tribal populations are growing (returning to pre-1855 levels), the needs for salmon are more important than ever.*
- *The annual return of the salmon allows the transfer of traditional values from generation to generation.*
- *Without salmon returning to our rivers and streams, we would cease to be Indian people.*

Icicle Creek lies entirely within the area ceded to the United States by the Yakama, Palouse, Pisquouse,Wenatshapam, Klickitat, Klinquit, Kow-was-sae-we, Li-Qy-was, Skinpah,Wash-ham, Shyikes, Ochechots, Kay-milt-pah, and So-hap-cat, a confederation of tribes considered as the Yakama Nation under the Treaty of June 9, 1855, 12 Stat. 951. The Yakama Nation and the Colville Confederated Tribes have litigated fishing rights in U.S. v. Oregon, where the Court held that the Yakama Nation is the tribe with the right to exercise and regulate the fishing rights reserved under the 1855 Treaty in the area ceded by the Treaty. U.S. v. Oregon, 787 F.Supp. 1557 (D. Or. 1992), 29 F3d 481, 486 (9th Cir. 1994), and 43 F.3d 1284 (9th Cir. 1994), cert. denied, 515 U.S. 1102 (1995). The Yakama Nation's concern regarding Leavenworth NFH is based on its strong interest in treaty and non-treaty fishing activities on Icicle Creek, which are governed by the processes and agreements initiated under the Court's continuing jurisdiction in U.S. v. Oregon. The Colville Confederated Tribes' concern regarding Leavenworth NFH is based on the historic ties of its Wenatchi members to the Icicle Creek area, and because the Colville Confederated Tribes receive surplus fish from Leavenworth NFH, which are an important subsistence food source for tribal members. As a signatory to the 1855 Treaty, the United States assumed a trust responsibility to protect the terms and conditions of the Treaty, and is bound by the rulings in U.S. v. Oregon interpreting the Treaty.

Overriding Public Interest

The activities of the Leavenworth NFH are in the overriding public interest. This determination properly considers the economic, social, and environmental benefits of the Hatchery's operations.

Leavenworth NFH creates significant economic benefits to north central Washington and greatly adds a boost to the tourism economy of the city of Leavenworth. The Hatchery has become a popular tourist destination point in the community with annual visitation of approximately 150,000 people. Visitors represent diverse cultures and backgrounds and are a mix of all ages. A 2007 Hatchery demographic analysis shows a significant number of the visiting public coming from other parts of the United States. Other visitors represent 33 countries from around the world.

Historically, Leavenworth NFH is very significant in furthering the development of Leavenworth and its resources. It was one of the largest employers in north central Washington in the 1930's and 40's during the construction period and provided the Civilian Conservation Corps with many projects throughout those struggling times. Major interest in archiving the historical contributions of the Hatchery is currently underway by the national D.C. Booth Hatchery Society in Spearfish, North Dakota and the Upper Valley Historical Museum located in Leavenworth.

The Hatchery provides full-time employment for 20 employees. Annual salary for these employees is approximately $1.2 million. The Mid-Columbia Fisheries Resource Office, which works in conjunction with the Hatchery and is also located on Hatchery property, adds an additional 11 full-time and 10 seasonal/term staff for a total salary base of $1.3 million. In addition to this direct employment, the Hatchery generates substantial economic activity in the community which results in many indirect jobs through contracts, equipment suppliers, other employment programs, non-profit organizations, youth and volunteer work. In addition to jobs and local economic activity, the Hatchery adds significantly to the Chelan County tax base in central Washington.

Fish and wildlife-associated recreation, including sport fishing, makes large contributions to the rural areas of Washington state, such as Leavenworth. Washington State ranks first in the Pacific Northwest, and eighth in the nation, in spending by sport fishers, which totaled nearly $854 million in 2005. The Columbia River spring Chinook salmon fishery is estimated to generate a $15.4 million annual economic impact, according to the Northwest Sportfishing Association. Salmon produced from Leavenworth NFH which are harvested in Icicle Creek provide one, if not the only, consistent tributary sport fisheries in the upper Columbia River. Based on information collected during the 2007 creel survey on Icicle Creek, a total of 1,058 anglers fished 7,754 hours catching 115 spring Chinook salmon produced by Leavenworth NFH (Viola 2007). In 2007, this fishery alone has a contribution value of more than $402,000 to the local economy (Viola 2007).

During the years 1999-2003, sport anglers in Icicle Creek harvested an average of 1,252 spring Chinook salmon produced at Leavenworth NFH (Table 8). Additionally, 732 of Leavenworth NFH produced spring Chinook salmon are harvested by sport anglers in the Columbia River annually (Table 8). Only a small number of Leavenworth NFH's fish are captured in Pacific Ocean fisheries (Figure 11 and Table 8).

Figure 11.

Leavenworth NFH spring Chinook contribution rates by fishery, 1996 - 2006.

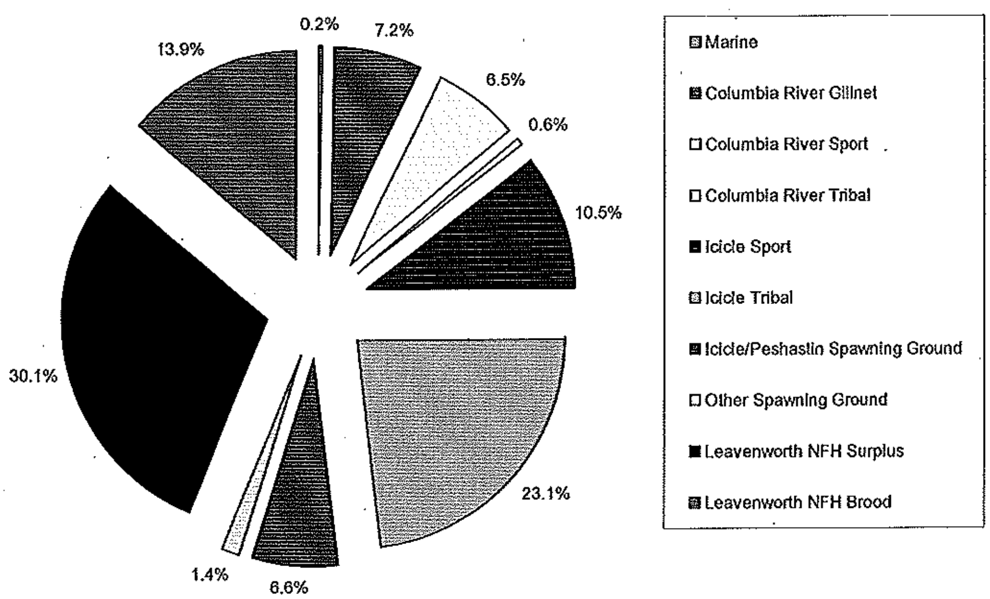

Table 8. Cumulative summary of returning adult spring Chinook salmon deposition for the Leavenworth Complex, 1999-2003 (Cooper 2006).

Recovery / Fishery Location	Leavenworth NFH		Entiat NFH		Winthrop NFH	
	#	%	#	%	#	%
Hatchery Brood	6,323	11.2%	1,973	20.9%	2,498	26.8%
Hatchery Donated Surplus	17,505	30.9%	6,174	65.3%	0	0.0%
Treaty Ceremonial	14,526	25.6%	78	0.8%	40	0.4%
Freshwater Sport	6,262	11.0%	9	0.1%	19	0.2%
Columbia River Gill Net	4,175	7.4%	512	5.4%	651	7.0%
Spawning Ground	4,053	7.1%	211	2.2%	5,426	58.2%
Columbia River Sport	3,686	6.5%	469	5.0%	659	7.1%
Test Fishery Net	0	0.0%	0	0.0%	1	0.0%
Freshwater Net	0	0.0%	2	0.0%	4	0.0%
Estuary Sport	0	0.0%	1	0.0%	0	0.0%
Ocean Troll	148	0.3%	19	0.2%	18	0.2%
Ocean Trawl	9	0.0%	0	0.0%	0	0.0%
Commercial Seine	0	0.0%	4	0.0%	0	0.0%
Above Rock Island	48,122	84.9%	8,464	89.5%	7,921	85.0%
Grand Total	56,685	100.0%	9,452	100.0%	9,316	100.0%

Local Native American Tribes also benefit from the adult spring Chinook salmon produced by Leavenworth NFH. In the years 1999 through 2003, the average annual number of adult spring Chinook salmon adults captured in Icicle Creek by tribal anglers was approximately 2,905 fish (Table 8) and approximately 835 are captured by Native Americans in the Lower Columbia River (Table 8). An economic value cannot be placed on a salmon caught by a tribal member because they consider the fish sacred.

If the number of salmon entering the adult holding ponds exceeds the number needed for production, the excess salmon are "surplused" to Native American tribes. The surplused fish are essential to local Native American tribes for subsistence and ceremonial purposes, and the economic value of the fish cannot be assessed. The Tribes who have received surplus salmon include the Yakama Nation, Colville Confederated Tribes, Spokane Tribe, Kalispell Tribe, Cour d'Alene Tribe. If tribes decline the surplus fish, then they are given to Trout Unlimited through a formalized agreement. Trout Unlimited uses profits generated from the sale of those fish for environmental education and aquatic habitat projects which benefit the Leavenworth NFH. Approximately 3,501 spring Chinook salmon produced at, and return to, Leavenworth NFH are surplused annually (Table 8).

The Leavenworth NFH is home to one of the largest comprehensive Environmental Education and Visitor Services programs in the National Fish Hatchery System. Alone, the annual Wenatchee River Salmon Festival hosts 10,000 people at the Hatchery each fall. Visitors and participants come from around the Pacific Northwest, with 40% staying more than one day in the Leavenworth area. The Leavenworth Chamber of Commerce has determined that, with an average expenditure of $300 by each visitor for lodging, meals, transportation, and shopping costs plus a volunteer value reaching $63,250, the festival generates $903,250 to the economic base of the community.

A unique program at the Hatchery involves recreational special uses. Year-round uses include horse and sleigh ride concessions, Leavenworth Summer Theater outdoor musical productions, and a 10 kilometer cross-country ski and snow shoe trail system managed by the Leavenworth Winter Sports Club (LWSC) and used by thousands of people throughout the winter. During the 2007-2008 season, the LWSC carried an annual payroll expenditure of $174, 842, employing 30 seasonal staff. With 107 days of cross-country trail operation, receipts for ski trail passes and memberships reached $179,299. One day to multi-day special weekend events also permitted on Hatchery grounds include birding and wildlife nature walks, marathons, Eagle Scout programs, Colville Tribal Pow Wow, Washington State Special Olympics cross country ski competition, Arbor Day, National Fishing Week events, handicapped fishing, Volksmarch, river tubing and rafting, snowshoe walks, weddings, trainings and teacher workshops. The economic value associated with public use at the Hatchery is over seven million dollars annually (Table 9).

Table 9. Estimated current economic value of permitted public uses on Leavenworth NFH land:

Event/Activity	Estimated Economic Value ($)
Leavenworth Summer Theater	1,720,000
Icicle Outfitters Horse and Sleigh Rides	93,180
Icicle River Ski Trail	4,665,600
Other Uses – general one day and multi-day use	1,250,000
Total	$ 7,479,030

Located on Leavenworth NFH grounds is the Cascade School District's Cascade Discovery Alternative High School which includes a classroom building, greenhouse, garden, storage sheds and parking. One full- time educator and one full- time para-educator manage the education program for approximately 25 students through the entire school year. This unique school is state accredited and has graduated more than 150 students since it began in 1993. Hatchery staff provides mentoring and vocational training and resources for these students. Additionally, two scholarships are made available to surrounding school districts, offering substantial funding for graduating high school seniors in pursuit of a higher education in a natural resource related field. One comes from the Salmon Festival and once comes from the American Fisheries Society Hutton Scholarship program.

The Hatchery maintains widespread public support among residents of the local community and beyond. The non-profit Friends of Northwest Hatcheries is based on the Hatchery compound, and its mission is to provide volunteer support and funding for quality natural resource conservation education and interpretation. Connecting people with nature is at the heart of the Hatchery's outreach program. In fiscal year 2007, volunteers donated 13,250 hours of time working on habitat and wildlife projects, environmental education, maintenance, cultural resources and recreation programs. The value of volunteer contributions for this past year reached $159,000.

In addition to the Hatchery's substantial economic and community benefits, the Hatchery furthers the public's interest in the environment. The Hatchery takes important measures to be environmentally sensitive in managing its facilities, water, and land base. It has been recognized by the USFWS with a national Environmental Leadership award. The quality of the salmon raised at the Hatchery is high and considered one of highest valued natural resources in the state.

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